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May 24, 1928

Engineering News-Record

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Precast Construction on Havana Seawall

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Eliminating Personal Profits

RAILROAD consolidation plans received a bad setback last week. The project for joint control of the Wheeling & Lake Erie Railway by the New York Central, the Baltimore & Ohio and the Nickel Plate was disapproved by the Interstate Commerce Commission, and approval of the Chesapeake & Ohio Railway's plan for consolidation with the Pere Marquette and the Erie received only grudging approval of the Pere Marquette control and disapproval of the Erie acquisition. Moreover, in the Wheeling & Lake Erie case the commission subsequently called upon the three roads to show cause why they should not be required to divest themselves of their stock holdings in the Wheeling & Lake Erie. At this early date it is difficult to judge how significant these two decisions will be, but it is evident that in the Chesapeake & Ohio merger case the commission is determined to keep railroad consolidations from being used to enrich their promoters. By eliminating the opportunity for personal profit, the commission may have found a way of determining whether or not improvement of the country's transportation system is the real object in any railroad consolidation proposal.

Flood Protection by Law

A YEAR'S campaign of study and discussion came to an end when the President last week signed the Mississippi flood-protection bill. Accordingly, it is now the law of the land that the floods of the Mississippi River shall be completely restrained, and further that this task shall be carried out by the Nation at large with substantially no local contributions. The work is to be done for slightly more than $300,000,000, a figure based directly or indirectly on the cost estimates of the Jadwin plan submitted last December. No one seriously believes that the cost will remain within this figure, nor does any one seriously doubt that the additional hundreds of millions likely to be required for the execution of a complete project will be granted by subsequent Congresses. Thus the Nation has for the first time committed itself to full responsibility for local flood protection. The case of the Mississippi is quite special, it is true, but so is every other flood case. A precedent has been set up which is sure to see many interesting applications in future. However—to look at the bright side of the matter—the present Mississippi legislation as well as similar future laws for other rivers will mean more thorough and more determined engineering attack upon flood problems, and this will be no small gain.

Commendable Promptness

PRESIDENT COOLIDGE acted with praiseworthy promptness in completing the flood board provided in the Mississippi bill. His selection of C. W. Sturtevant if as promptly confirmed by the Senate will enable the detailed study of plans to begin at once. The task is one of great difficulty. Not to mention its economic phases, the physical side alone contains many uncertain factors. They are the components of the unknown three terms in the basic equation $Q = Av$, an equation which incidentally expresses the will of Congress that the greatest possible flood of the future, Q second-feet, shall be passed through the channel section, A square feet, which the engineers will provide, and that it shall do so at the velocity v which Nature is pleased to impose on the flowing waters. We have consistently held that this complex problem demands the co-operation of the broadest possible range of engineering ability, and that this could be achieved only through a consulting board of the ablest civil engineers in the country. Congress has decided otherwise. Nevertheless, we take the hopeful view that the present board of three will succeed in establishing a sound basis for the ultimate control of the Mississippi floods. Its members are seasoned in knowledge and study of the river, and, while two of them have already formed definite conclusions, the leaven introduced by the new member is bound to have a wholesome effect. The board's decisions, in any event, will probably not determine the course of the enterprise throughout the full duration of the work—a dozen years or more. It will determine the construction work of the next year or two; but subsequent studies and experience will yet be able to show whether and how the initial plan requires modification.

Bidding With Conscience

IN THE practice of letting contracts for construction it has long been a fixed rule that bids shall be accepted as first submitted. Haggling and private bargaining after opening bids are universally recognized as illegitimate, and everyone concerned with construction is conscious of the subverting consequences of violating this principle. The same principle, we are glad to learn, is now being stressed as a fundamental in the related field of general purchase of material and machines. Within the month, at a conference arranged by the National Association of Purchasing Agents, W. W. Nichols, of the Allis-Chalmers Company, and T. W. Harris, of E. I. du Pont de Nemours & Company, brought it into the foreground as the basic principle of sound purchasing and the main reliance against the evils of competitive haggling that have lately become epidemic in corporate buying and selling. E. E. Whitehorne, commercial editor of *Electrical World*, who first studied these practices and gave the incentive to the conference mentioned, has shown in a series of articles on what he called "purchaser profiteering" what forms these practices take and how they tend to degrade the quality of production. Both producer and consumer are vitally concerned in this matter, for the essential interests of both are at stake. But if those engaged in general purchasing are now struggling to lift themselves out of the difficulties caused by unsound bidding and buying practices, it is a good time for con-

struction interests to be warned by the example. In construction contracting, cases arise almost daily where it is proposed to abandon the principle of fixed bidding by arranging privately with one bidder for a revision of contract and price. Regardless of the nature of the parties involved, whether municipality or corporation, material man or contractor, such departure is destructive and unsound. If contracting is to be kept sound, it can only be by respecting the binding character of a bid once made.

Fire Hydrant Maintenance

AT INTERVALS of 300 to 400 ft. in every well-ordered city the fire hydrant stands as a symbol of instantaneous aid in case of fire. Conversion of the symbol into actuality depends on the hydrant being kept ever ready for efficient use. This means thorough inspection, tests, and, if need be, repairs. There is no one hard and fast rule for doing this work. Information as to efficient methods and their cost is not over-plentiful, and whenever this is the case considerable actual neglect is apt to be found. For example, in a summary of the way inspection work is being done at Knoxville, Tenn. (*Engineering News-Record*, April 26, 1928, p. 629), it was related that the first thorough survey showed a third of the hydrants in need of repairs. The warning which Knoxville's experience carries for other cities should stimulate other needed fire hydrant surveys.

Emergency Contracting Service

FORMAL organization of its 110 chapters and branches to insure quick mobilization of construction forces for restoration following great disasters is being sponsored by the Associated General Contractors of America. At their recent spring meeting in Washington action was taken on a committee report recommending for each chapter a close tie-up with the American Red Cross bureau of restoration for the purpose of aiding alike in dispatching restoration work, in securing competent contractors and in combating extortion. This cooperation had been asked by the Red Cross officials as the result of their experiences in the New England and Mississippi Valley floods. In both of these emergencies the greatest difficulties of the reconstruction operations had been to secure competent estimates, reliable contractors and fair prices. Obviously these are tasks in which organized contracting can be of vital aid. The work done by the Southern California Chapter of the A.G.C. following the failure of the St. Francis dam is certain evidence. As fully related in our issue of May 10, the local chapter arranged to place in the field a force of 1,200 men, equipment costing $1,500,000, and ten competent contractors, with commissary and lines of communication established, within 48 hours after the call for mobilization had reached the officials of the chapter. That the contractors in the territory of the stricken Santa Clara Valley were willing to help was a foregone conclusion, that their work was well done has been attested, but that they could be mobilized and in 48 hours would be pressing the attack of restoration with the speed and sureness of a trained army was a revelation. Such preparedness could not have been a possibility except for closely knit organization. It is in developing stand-by organizations for meeting similar emergencies that all the chapters of the A.G.C. plan to ally themselves with the Red Cross and other agencies for handling restoration construction. The action is one of practical service to government and people.

New Demands and New Methods

A FEW weeks ago, publication of the design studies for the Owyhee dam brought to notice a remarkable example of the new demands which modern times impose upon structural engineering, and of the new methods developed in response thereto. An instance in a different field is presented by the analysis of the Hudson River bridge towers in this issue. The increased demands in part grow out of the advance of the engineering art itself; thus, in the Owyhee case the high development of dam study made it possible for the engineers to work out five alternatives and thus to choose the most advantageous solution of the problems imposed by the site. But in large part the modern demands arise from the magnitude of our structures, which in many cases, as in the Hudson River bridge, attain truly gigantic dimension. Great magnitude often gives decisive importance to factors that are negligible in small-scale work; the entire problem is invested with new difficulties, and in consequence the designer's work must be put upon a new and higher plane.

Mr. Moisseiff's account of the analytical studies of the towers constitutes a notable essay on structural framing. The recourse to comparative analysis of variations in the frame, as a device for revealing what the author calls the sensitiveness of the tower structure, is an important innovation, one that seems to have useful application in many other structural problems. Appraisal of stresses by plotting the zone of variation over which the stresses shift when the character of constraint in the frame is changed—as it may be by conditions of manufacture or erection, for example—reflects a constructive attitude toward working stresses. And the verification of calculated stresses by strain-gage measurement adds that undeniably convincing effect which always results when an intricate matter is made concretely simple and tangible.

These huge steel towers are in many respects the largest and most important examples of statically indeterminate steel frames ever projected. As such, they recall the time when it was almost an axiom in structural engineering that "simple"—that is, statically determinate—forms of assemblage are always to be preferred. Practice has developed greatly since that time, and in so far as the principle still expresses a prevailing trend of thought it is limited to structures of small and moderate size. Even here it has only restricted meaning today, for with the universal adoption of rigidly riveted connections in steel construction, and the protean development of reinforced-concrete practice, the characterization "statically determinate" survives only as a convenient fiction. Actually, modern engineering practice deals with constrained structures almost exclusively.

If, for example, a railway plate-girder bridge spanning 80 or 100 ft. be considered, the existence of extreme and highly intricate constraint within the structure can hardly fail to be recognized. Everywhere in bridge and roof construction, in the framing of buildings, and the like, the same condition exists, and throughout the field of structural design we find ourselves dealing with constrained structures, or rigid frames, in nearly every instance. Whenever the action of the "simple" component of the structure is dominant, the analysis of stress action may (and usually should) be conducted on a statically determinate basis—though, of course, the engineer must have a clear appreciation of the local effect of the actual constraint. Within the range of ordinary proportions and well-standardized types of structure, experience furnishes

thoroughly satisfactory guidance and justification for this proceeding. But it fails in unusual forms or types, as well as in abnormal magnitudes. There, a direct recognition of the constraint becomes necessary, and statically indeterminate calculation in one form or another must be resorted to.

Practice has advanced in this direction progressively for many years. Now that men's wants are growing more ambitious from day to day and engineering works of great size are needed—as characteristically in the large and active bridge construction of the present day—the demands upon engineering art and skill make inevitable still further departure from past forms of design and traditional methods of study. New problems bring forth new thought and new methods. Thus, the present time is giving a stimulus to engineering science which is bound to have significant results. The design of the Hudson River bridge towers serves as both stimulus and model; it will aid in the development of the bridge engineering of the next generation.

Time for Change of System

STEADY progress downhill is being made in the administration of irrigation in the Western states. Congress has long had the habit of tinkering with the management system originally set up, and continues to tinker, in nearly every case destructively. Business cannot continue sound under these methods. The final outcome can only be a waste of public funds, a blighting of the regions directly affected and a paralysis of irrigation development.

Irrigation as a venture of private business has been virtually killed off by the federal operations in the same field on a subsidy basis—for it is a fact, though not generally known in the East, that the Reclamation Act subsidizes or endows the local landholding beneficiaries by more than half the cost of the improvement. If the federal work also is to go on the rocks through bad business management by Congress, it will be equally unfortunate for citizens and engineers.

While we have repeatedly referred to the reclamation tinkering in the past, a new attempt of the kind invites attention. Two years ago, it may be recalled, Congress passed a blanket readjustment act, which wiped out some twenty-five million dollars of the total amount which the reclamation beneficiaries owed to the government (owed by contracts voluntarily and even eagerly entered into, be it noted). With this act of wholesale charity, it was believed by Congress that there would be no more of the continual complaint and requests for postponement or cancellation of payments which had marked the history of federal reclamation for many years. The event belies the belief. Requests for further largess have continued since 1926, and it now appears that at least some members of Congress are ready to accede to them.

One of the most prosperous of the federal projects, the Rio Grande, has been making its installment payments of construction cost on the basis of twenty annual payments, as provided by law. Last year, however, it requested the Interior Department to extend the period of payment from 20 to 40 years, as permitted by recent relief legislation in case of severe economic conditions. A special economic board appointed to examine the project reported against the request, as being in no way required or justified by the financial condition of the landholders and as tending only to encourage the existing evil of land speculation and high prices. Now, however, the request having been renewed, the irrigation and reclamation committee of the House has voted to override the refusal of the department and to grant the request by extending the payments to 30 years. It has so reported to the House.

Thus the administrative organization on which rests the responsibility for managing federal reclamation—namely, the Interior Department (through its Bureau of Reclamation)—finds its essential responsibility taken out of its hands and assumed directly by Congress. There has been much discussion of late about the warping of our government structure through the exercise of legislative functions by the executive and the judiciary. Little has been said of the usurpation of administrative functions by the legislature, as in this case. Yet it will be clear that the latter may do as much harm as the former.

Like the income tax bureau or the federal land banks, the Reclamation Bureau is under a special obligation to the people of the country. It has the duty of collecting regularly and with even-handed justice certain moneys owed to the Nation. To fail in this duty is as demoralizing in the one case as in the other. Congress would not think—at least has not yet thought—of remitting the income tax of the residents of El Paso or of the entire Rio Grande project area. But it lacks the same moral sense in its attitude toward reclamation debts.

The whole course of federal reclamation, viewed in retrospect, reveals that for fifteen years it has moved steadily toward complete cancellation or repudiation of the government debt. Among reclamation politicians, bankers and landowners, repudiation sentiments have long flourished, but Congress has never openly aligned itself with this sentiment. In the Rio Grande case an influential committee of Congress comes perilously near doing this.

To the Western Congressman the reclamation debt is a mere formality; the only thing that counts is that reclamation projects shall be built with government money. But the ordinary citizen, and we trust also the Eastern Congressman, cannot look with approval on the government's engaging in non-paying business enterprises for the exploitation of private interests. The most powerful reasons of honesty and good public policy oppose such diversion of public funds.

If the new departure means, as on its face it seems to mean, that within the halls or committee rooms of Congress the national equity in the reclamation investment is not looked upon as anything serious or real, then it is time to record the final death of the policy of federal reclamation. In that event, obviously, no new reclamation projects should be undertaken. If construction of a project in fertile southern regions at a cost of $90 an acre leads to bankruptcy, is it good business to begin work on a less favored northern project which will cost more than $160 an acre? Is it not rather time to terminate the 26-year-old reclamation adventure and delete the famous act of 1902 from the statute books?

If the action on the Rio Grande request is justified, reclamation is openly bankrupt. If the request is not justified, on the other hand, not only should it be rejected when it comes before the House but an administrative system should be established that will assure enforcement of reclamation collections in as impartial and businesslike manner as the collection of taxes or land-bank loans. In either event it is timely that a new system be instituted and that Congress permanently remove the reclamation enterprise from the unwholesome atmosphere of political bargaining.

Precast Concrete in Havana Seawall

Compact Casting Yard for 50-Ton Blocks and 100-Ft. Piles—Cross-Transfer Track Enables One Gantry to Serve Three Block Yards—Floating Templets Guide Piledriving

By C. C. Fitz Gerald
Havana, Cuba

THE casting of very large hollow concrete blocks to be filled, when placed, with concrete deposited by tremie, and the handling and driving of notably heavy precast concrete bearing and sheet piles signalize the new seawall construction at Havana, Cuba. As the construction has been delayed and the original plans altered and as there is possibility of future changes and uncertainty of progress, this article describes only the work that has been done: The casting yard arrangement, which is unusually compact; the block and pile design and construction, and the piledriving methods. These problems were worked out while the writer was associate partner of the general contractor, Arellano y Mendoza, of Havana.

Seawall Structure—The new seawall at Havana is a prolongation of the existing seawall along Avenida del

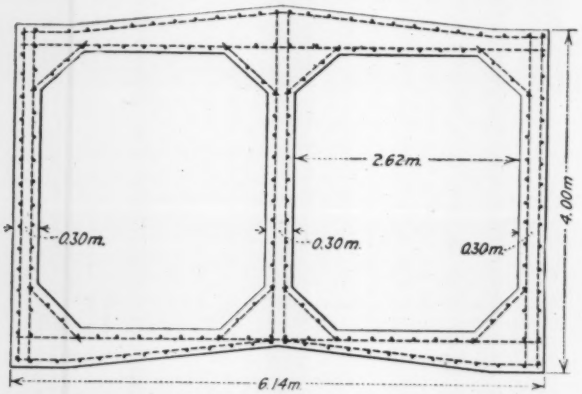


FIG. 1—TYPE OF PRECAST HOLLOW BLOCK FOR SEAWALL
When placed under water, the plan was to fill the blocks with tremie concrete.

Golfo (Gulf Ave.). As planned it called for a monolithic concrete wall 1,070 ft. long in water of about 14 ft. maximum depth; a block wall 1,608 ft. long, and a pile wall 1,410 ft. long. These plans required: (1) 5,676 cu.yd. of 1 : 3 : 5 concrete in the monolithic wall; (2) 9,940 cu.yd. of 1 : 2 : 4 concrete in precast blocks and 1,720 cu.yd. of 1 : 3 : 5 tremie concrete to fill the blocks and make a footing for them; and (3) 18,300 cu.yd. of 1 : 1½ : 3 concrete in precast piles. Changes in construction have altered all these volumes except that for precast piles.

Hollow Precast Blocks—The plans called for eight sizes of precast blocks, with a few specials, of the general type shown by Fig. 1. The standard blocks required from 17 to 23½ cu.yd. of concrete and weighed up to 45 metric tons. Some of the special blocks weighed up to 75 metric tons. The blocks were cast in steel forms. The reinforcement was assembled in cages over a wood frame or templet and the cages were picked up by a locomotive crane and set inside the forms.

Precast Piles—There were three kinds of piles called for by the pile wall, as shown by the section, Fig. 3: (1) Bearing piles (vertical) 16 in. square up to 50 ft. long and 20 in. square when longer; (2) batter piles 20 in. square, and (3) sheet piles 25x20 in., of the cross-section shown by Fig. 2. Altogether there were 407 vertical piles, 316 batter piles and 1,716 sheet piles varying from 36 to 100 ft. long.

Casting Yard and Plant—As the blocks and piles had to be cured 30 days, a large casting and curing area was

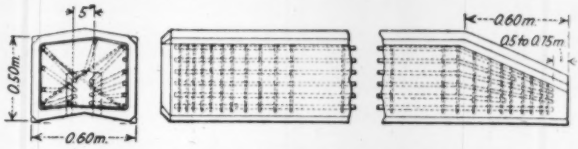


FIG. 2—DETAIL OF PRECAST SHEET PILE

required and the ground had to be capable of bearing considerable loads. The land most available (Fig. 4) was a hydraulic fill of mud and was quite soft. A retaining bulkhead of timber was built and the mud was covered with a 3-ft. layer of rolled hard material. A test of this rolled fill indicated a safe load of 1,400 lb. a square foot.

The yard layout (Fig. 4) is particularly to be observed. Cement came in by barge; stone by road or railway; sand by road or railway or by barges unloaded to railway cars running to stockpiles, and reinforcing steel by railway. All these methods of materials delivery were provided for in the railway, road and pier layout shown. Power was the next general service after transportation, and it was provided by a system of electric transmission lines equally as comprehensive as the transportation lines. These general services served four main production and delivery units, arranged end on to the water front.

There were, first, the block-casting yard and the pile-casting yard, both terminating at the waterfront in slips for barges; second, the concrete mixing and placing unit

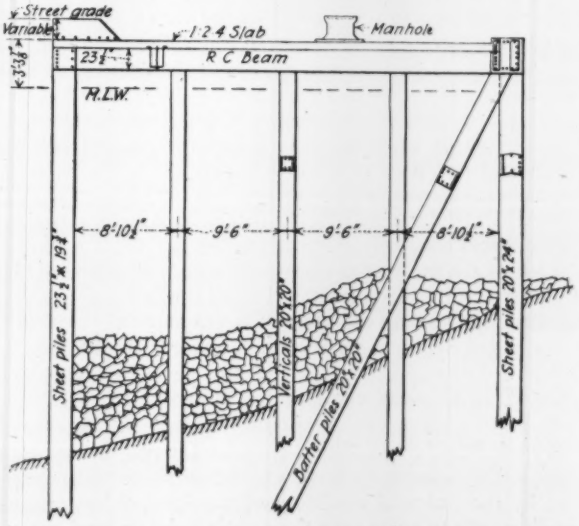


FIG. 3—TYPICAL CROSS-SECTION OF PILE SEAWALL

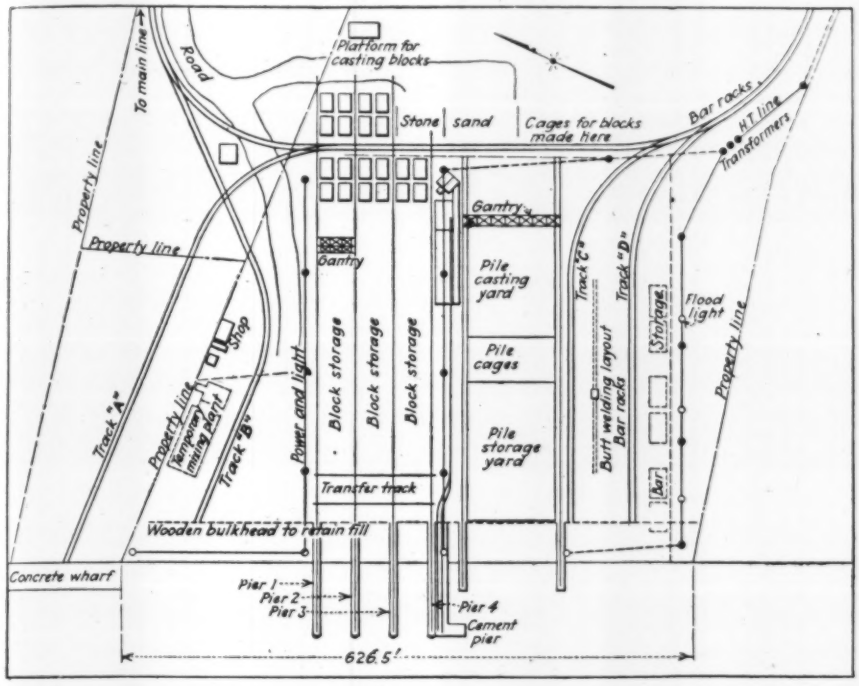


FIG. 4—PILE- AND BLOCK-CASTING YARD LAYOUT

between the two casting yards and serving both, and, finally, the reinforcement fabricating unit at one side of the yards and connecting to them by railway. Of these units the most notable was that for block casting; divided into three bays by gantry runways, all served by a single gantry shifted from one to the other as desired by means of a transfer track, this casting yard is a useful example of compact, large-block, casting-yard arrangement. The plan, Fig. 4, indicates the orderly routing from the delivery of materials to the shipment of the cast blocks and piles. In this routing, besides the railways, the important handling units were two gantry cranes with runs from the casting yards to piers reaching out into the water and having barge slips between them.

There were two gantries, one serving the block yard, with three runs, and the other serving the pile yard. The block gantry had a span of 42 ft., was mounted on sixteen wheels and had a capacity of two 50-ton blocks or one 100-ton block. The pile gantry had a span of 110¼ ft. Both gantries were driven by 15-hp. backgeared motors coupled to shafts, with chain drives to one axle and chain-drive couplings to the other axles. The driving axles had equalizing devices to meet inequalities in track. The block gantry was notable in having to cross the railway track at the rear of the yard and in being designed to be shifted back and forth between runway bays. To cross the railway, pieces of gantry rail were set across the track rails, which were low enough to permit this, and the across-railway gap in the runway track was

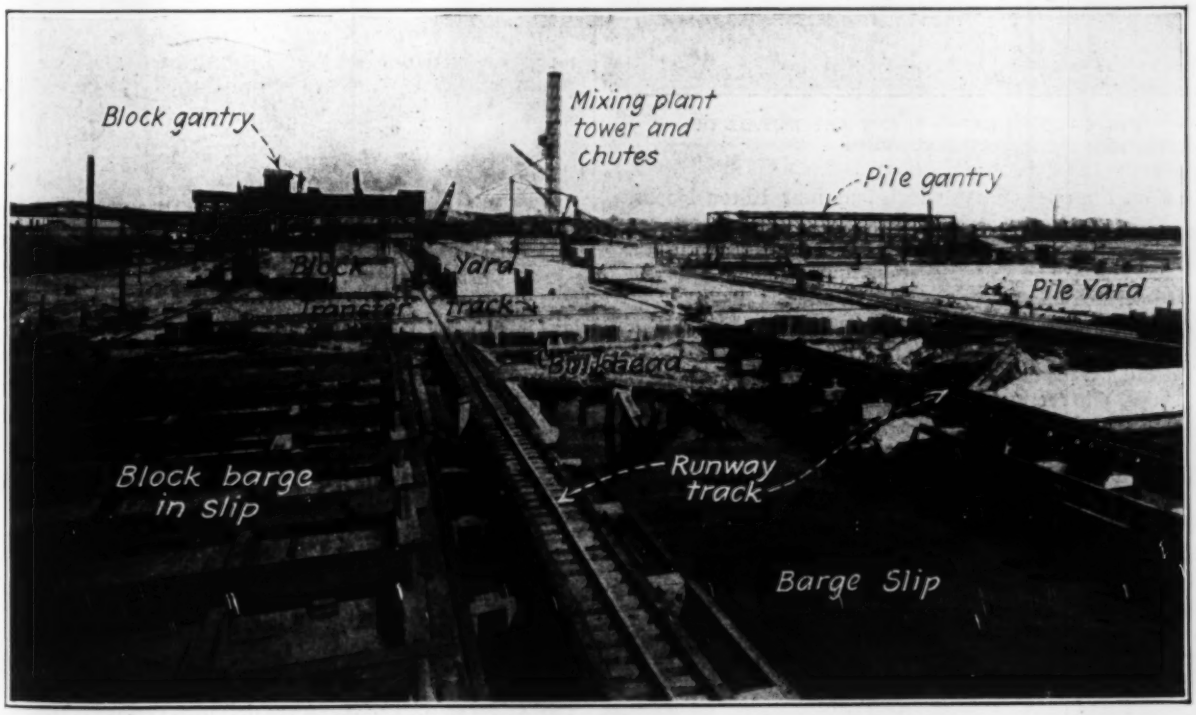


FIG. 5—PILE- AND BLOCK-CASTING YARD IN OPERATION

closed. At the transfer track, whose rails were higher than the runway rails, the crane was jacked up and short pieces of rail were inserted in the gaps over the runway rails. Fig. 5 shows the relation of transfer and runway tracks.

For handling blocks, the block gantry was equipped with eight 12-ton spur-geared blocks with chain-operated trolleys; for blocks weighing more than 50 tons the blocks were coupled in pairs by equalizer beams. Experience with these blocks indicated that were wages high, it would pay to put in electrically operated blocks. These were

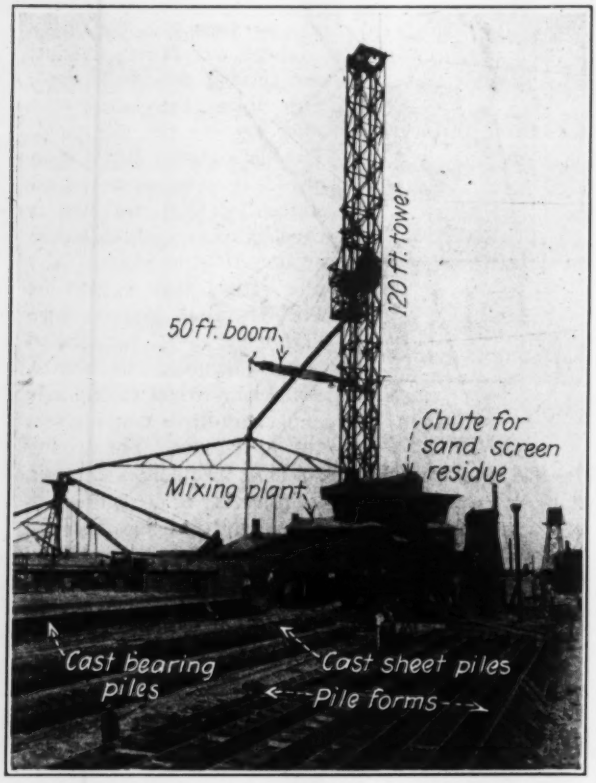


FIG. 6—CONCRETING PLANT AND DETAIL OF PILE CASTING

used on the pile gantry, which had four 10-ton blocks. The motors were wired so that a strain could be taken on each block in turn, and when they all had their strain, the piles could be raised evenly by pressing one switch that operated all motors at the same time.

Of the yard outfit, that next in importance to the gantries was the concrete plant. This is shown by Fig. 4 and in detail by Fig. 6. At first, before this plant was got in shape, pile casting was begun in the space each side of track *A*, and a tower mixing plant was located near by as shown by Fig. 4. The mixing plant was steam driven. It had a steel self-cleaning aggregate bin holding 117 tons, stone batcher, sand inundator, 120-ft. tower and a 50-ft. boom and counterweight chuting system. Incidentally, there was a sand screen to remove shell and rock fragments from the local coral sand, which is marketed unwashed and unscreened. As the specifications did not call for any water-cement ratio, the inundator and batcher served no very practical purpose except possibly that of keeping the inspector from bickering over water and sand proportions.

Casting Procedure—The casting platforms consisted of

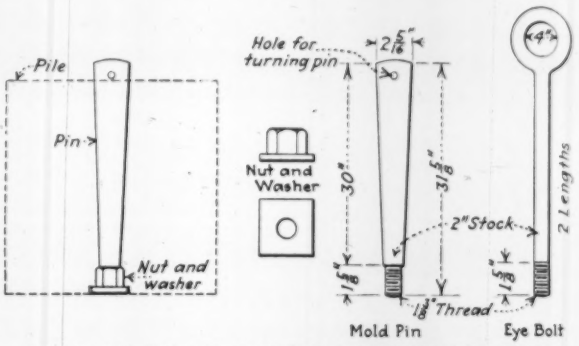


FIG. 7—LIFTING HOLD DETAILS FOR PRECAST PILES

1⅝-in. plank laid on 4x6-in. sills, 16 in. on centers, laid in sand or stone dust and fine screenings on the rolled fill. Steel forms were used for the blocks, and these and the cages of reinforcement were handled, as before stated, by locomotive crane. There were two of these, one 25-ton and one 40-ton, in the yard equipment. The pile forms were of wood, and they and the reinforcing cages were handled by the gantry. As shown by Fig. 6, alternate pile forms were set up which were removed when the pile had set. Then the spaces between piles were used as molds by pasting paper on the piles first cast so as to prevent adhesion. The pile cages were assembled complete and so placed in the molds, all longitudinal bar splices being electrically butt welded. While no water-cement ratio was specified, the pile mix was given 5½ gal. per sack and the block mix was given 6¼ gal. per sack.

To handle the piles to storage and onto the barges, holds for eye-bolts were cast in them. The arrangement is indicated by the sketch, Fig. 7. A 1⅝-in. nut with a

FIG. 8—PILEDRIVING OPERATION, SHOWING HAMMER AND FLOATING TEMPLET

4x4-in. washer welded to it was set on the form bottom, washer down, at each lifting point. Into the nut was screwed a steel taper pin. After the pile had been molded about six hours the taper pin was screwed out, leaving a hole with the nut and washer at the bottom. To keep the pin loose for withdrawing, it was greased and twisted from time to time. When withdrawn, the hole was corked until the time to lift the pile. Then eye-bolts were screwed into the nuts and the pile was ready to lift.

Piledriving Procedure—The wall structure (Fig. 3) required both vertical and batter piledriving. For the vertical piles a derrick boat was used, which lifted the pile from the barge and up-ended and "set" it. Then the derrick swung the hammer onto the pile and it was driven as shown by Fig. 8. The batter piledriver had inclined leads mounted on a barge and the same type of hammer as is shown by Fig. 8. The main problem of the piledriving was to get true alignment. The method employed for guidance was a floating templet of timber shown by Fig. 8. Wood anchor piles were driven, and to them the floating frame of timbers was fastened and braced to exact position. As the concrete piledriver proceeded, the timber piles were pulled and the templet was anchored to the concrete piles. Alignment generally was not hard to secure, but uneven penetration left many pile tops to be cut off before the wall deck could be built.

Direction of Work—The seawall at Havana is being built by the Department of Public Works of Cuba, of which Carlos Miguel de Cespedes is secretary and Jose I. del Alamo is engineer in charge.

Kwangtung Conservancy Board Labor Problems

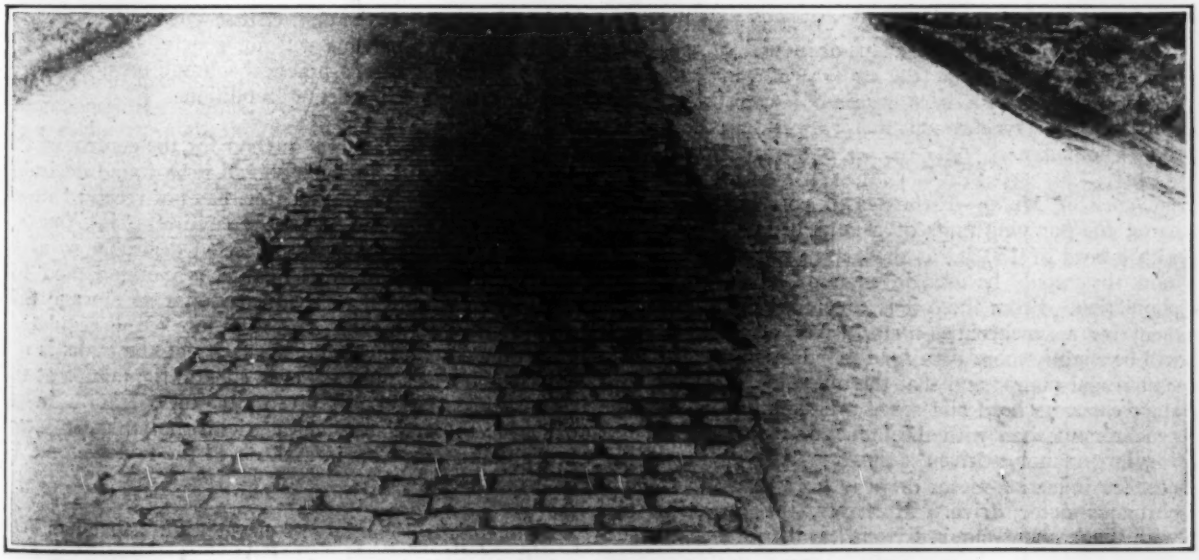
The world-wide extent of labor problems confronting municipal administrators is shown by the following extract from the latest annual report of G. W. Olivecrona, engineer-in-chief, Kwangtung Board of Conservancy Works (flood protection), dated Canton, China, December, 1927: "The year under review shows a marked change for the worse with regard to the laborers' working capacity, discipline and general behavior, and with demands of unusually high wages. Skilled laborers, such as carpenters, blacksmiths, engine-drivers, bamboo-riggers and others, are difficult to find, while those who offer their services are poor craftsmen and turn out second-class work. As the labor unions have declared an eight-hour day at daily wages considerably higher than those of a few years ago, it follows that with laborers quitting their work several times during a day for rest and tea-drinking, employers do not obtain the full value of eight hours' work per diem. This has resulted in the cost of construction increasing to such an extent as to render it inadvisable to tackle work of any magnitude where skilled labor is required until such time as labor conditions have become stabilized and the unions better organized. Simple earthwork calling only for farm hands and unskilled labor can still be performed at a reasonable price."

Grout Outlasts Sand as a Filler for Brick Pavement

By P. J. Freeman
Chief Engineer, Bureau of Tests, Allegheny County, Pittsburgh, Pa.

AN EXAMPLE of the older practice in brick road construction, which seems to offer a lesson to present-day practitioners, is illustrated by the accompanying view. This road, known as the Thoms Run and Oakdale road, was built in 1914 in Allegheny County, Pennsylvania. The idea was to use grout-filled brick along the edges, supported by wood planks as curbs, and fill in the center of the road with sand-filled brick. All brick were of equal quality, and the failure of the center is due entirely to the fact that the water ran down through the sand filler and destroyed the sand cushion underneath.

There was 7,300 ft. of this construction. The pavement was 16 ft. wide, made up of a middle sand-filled zone 8 ft. wide and two grout-filled side zones each 4 ft. wide. The base was 5 in. of concrete and the sand cushion was 1½ in. thick. The road has not been subjected to heavy traffic as we know traffic today, and the deterioration is due mostly to atmospheric conditions. The grout-filled sections are in almost perfect condition, whereas it is quite obvious that the brick are worn and cobbled in the sand-filled section.



BRICK PAVEMENT WITH SAND-FILLED CENTER AND GROUT-FILLED EDGES

Pumps and Elevated Tanks for Water-Works Systems

Changes From Reciprocating to Centrifugal Pumps Reviewed and Some Elements in Tank Design Considered

By George H. Fenkell
Superintendent and General Manager Water-Works, Detroit, Mich.

Abstract of a paper read before the Indiana Section, American Water Works Association, March 15, 1928. The paper in full appears in the *Journal*, A.W.W.A., April, 1928. The title of the paper was "Uses of Tanks in Water-Supply Systems," but it included considerable matter on pumps also, from which have been selected those portions which relate more particularly to pumps in their relation to elevated tanks. Editor.

THE types of steam pumps that were made available about 1890 were very reliable in operation and flexible in meeting the demands for water. With the use of water passages of ample size, and with an abundant number of water valves of ample area, these pumps could be operated in regular practice from about 10 per cent above normal capacity to about one-third below normal capacity, and at pressures one-third above normal to nearly 50 per cent below, with but little reduction in economy, the range of operation depending upon the design. The steam reciprocating pump was well adapted for use with a widely fluctuating load, and has been displaced largely by the centrifugal pump, which is best fitted to operate at constant discharge and at uniform pressure. While this change in practice was taking place, there has come an increasing insistence from the consumers for better and more reliable service, both for ordinary use and for fire prevention use. In a community in which it has been found desirable to deliver the supply of water through the use of motor-driven centrifugal pumps, it will be found that the constant-speed motor can seldom be used except by throttling, or bleeding, or by the use of the elevated storage of water. Variable-speed motors may be substituted, or a group of pumps may be installed in which both constant- and variable-speed motors are used. Constant-speed motors may be either of the synchronous or induction type. The lowest rates for current [the author states in part of his paper not otherwise here reprinted] can be obtained usually for the synchronous motor, operating throughout the 24-hour day.

Choice of Motor—Estimates of cost have been prepared for pumping units of 5- and 10-m.g.d. capacities, with a head of 150 ft., as those are probably the size of units that would be used in cities of 50,000 to 100,000 population. From these it is concluded that the investment for a synchronous-motor-driven centrifugal pump will be slightly more than for the induction-motor-driven centrifugal pump; and that the operating costs for constant capacity, head and speed are slightly less with the synchronous than with the induction-motor drive. But for larger motor-driven units, the relative investment cost for induction-motor drive is more than for the synchronous-motor drive. Moreover, the operating cost with synchronous-motor drive is less than with the induction-motor drive. When 5- to 10-m.g.d. units are operated at one-half capacity, the operating cost is slightly less when using a throttled discharge with a synchronous motor than with a variable-speed induction motor. The use of a blow-off or bleeder for the return of water from the discharge pipe to the pump well for pressure and discharge control is found to be uneconomical.

Advantages of Tanks—The elevated storage of water in a proper location will effect a reduction in the operating costs at the pumping station, but this saving alone may not justify the expenditure required for the construction of the tank. In fact this saving in operating costs is only one of the advantages that the tank makes possible, for this and others must be given due consideration: (*a*) Reduction of operating costs at the pumping station, (*b*) the maintenance of more uniform pressures throughout the year, (*c*) reduction of capital costs for pumps and mains to meet the peak demand, (*d*) improved fire service, (*e*) the maintenance of pressures during a short interruption of pumping service, (*f*) as pumping station attendants will not always operate the pumps in the most economical manner, there is an advantage from the use of a tank, as through its use less pump manipulation is required.

Tank Cost—The cost of an elevated tank will depend on the foundation requirements, but it may be expected that it will be, exclusive of site, and with a top elevation of 100 ft., from $10,000 for a 0.1-m.g. tank to $90,000 for a 1.5-m.g. tank. Smaller tanks will cost more proportionately. Only one tank with a capacity as great as 2 m.g. has been constructed so far [mentioned later], while four 1.5-m.g. tanks are nearing completion at Detroit.

Some of the matters that should be given careful consideration in the location and design of the tank have been well set forth by Nicholas S. Hill, Jr. (*Journal* A.W.W.A., November, 1926; abstracted in *Engineering News-Record*, June 17, 1926, p. 990). It is not always possible, however, to place the tank in its ideal location. Preferably it should be located on the side of the center of the district in which much of the water is consumed, opposite from the pumping station, near a main pipe line which is large enough to allow the tank to operate satisfactorily and upon land that is as high as or higher than most of the district that will be affected. As all of these requirements will not generally be met with in any particular case, a practical solution must be found that best meets the existing conditions.

Flow Control—The best method for the control of the flow in and out of the tank, should it be found desirable to attempt control to any degree, has not received much consideration from water-works engineers, in America at least. Tanks have been connected generally so as to float on the lines, and this method is most adapted for use in smaller cities, where the amount of storage that can be provided is sufficient to produce a full regulating effect, but in cities where the capacity of the tanks is not sufficient for this purpose, even though the pumps at the distributing station are given careful operation in an endeavor to correlate their use with the tanks, it seems probable that the flow in and out of the tanks should be controlled.

Foundations—The largest elevated tank that has been constructed is located at Charleston, S. C., and has been described by J. E. Gibson (*Journal*, A.W.W.A., Sep-

tember, 1927; see also *Engineering News-Record*, May 27, 1926, p. 849, for illustrated description of the tank—EDITOR). It has a capacity of 2 m.g., and Mr. Gibson states that "the settlement varied from ¼ in. up to 2.6 in., depending upon the load and the location. The tests indicated that there would be some settlement of the concrete foundation, but the question was to distribute the load on this soil so as not to exceed 2¼ tons per sq.ft., including the live and dead loads and foundations. This is mentioned here to call attention to the fact that unless founded on rock or very dense and stable material, settlement to some degree will almost certainly occur; that after this settlement has taken place, unless it has proceeded uniformly, the stresses in the tank are bound to be different than would have obtained had no settlement taken place; and that when the foundations and structural members are proportioned, consideration must be given to the effect of settlement.

There is a difference of opinion among those engaged in tank design as to how much load will be carried on the foundation for the riser and how much by the supporting columns, even without settlement. It is suggested that until the effect of settlement is better understood, the foundations for the columns be designed to carry all the load, irrespective of the fact that part of the load will undoubtedly be carried by the riser. As the foundations are of prime importance, this item should be well controlled and a thorough study should be made of the soil conditions at the tank site. The type of foundations should then be determined, such as a continuous ring or individual footings under the columns and the allowable working stresses, and the material to be used must be specified.

Risers—In practice there will be found a difference in the diameter of the riser, as determined by different manufacturers. The riser must support a considerable load, and consequently its foundation must be adequate and the thickness of its plates must be sufficient to give it the necessary strength. It is therefore believed that the specifications should state the load that the riser and its foundations should be capable of supporting, together with the diameter and minimum thickness of shell. The appearance of a tank can generally be improved through the use of a riser having a diameter of generous size.

The experience with tanks as large as or larger than 1 m.g. during the winter season in northern latitudes has been limited, because so few have been constructed, and consequently the trouble, if any, that will arise in these large tanks through the formation of ice is not well understood. Unless a tank is heated or protected, however, it should not be so operated that there will be but little flow in and out during severe freezing weather, for should the water which it contains remain at about the same level for a week or more, with air temperatures at zero or below, ice would form to a considerable thickness and trouble would likely ensue.

In determining the size of an elevated tank to use in any particular city, not only the balancing effect on the system must be considered but also the storage of water for fire-protection purposes. The latter generally increases in importance as the size of the city decreases.

Conclusions—(*a*) Through the use of the elevated storage tank, a supply of water is made available for fire-protection purposes. "The introduction of storage, either elevated and supplying the distribution system or for suction supply, offsets to a greater or less degree the need of duplication in various parts of a system, the value of the storage depending on its amount and location." ("Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defense and Physical Conditions," by National Board of Fire Underwriters.) (*b*) The proper size and location for an elevated tank for any particular city or town will depend upon local conditions. It should be placed in that area which is most in need of its beneficial effects, and that point is generally some distance removed from the pumping station. (*c*) The cost of a tank may only in part be justified by the estimated reduction in operating costs at the pumping station. This estimated saving in operating expense will probably be exceeded in practice, because of the failure of engine attendants to operate the pumps in the most advantageous manner, and because fewer changes in operating details are required when tank storage is available. (*d*) Through the use of an elevated tank a saving may be effected in expenditure for such capital cost items as pumps and mains, or the construction of such equipment and structures may be delayed for a time. (*e*) Trouble from water hammer is sometimes experienced when reciprocating pumps are used in a direct pressure system. The use of an elevated tank may reduce this operating difficulty. (*f*) Some of the standpipes that were erected some years ago and which are located at or near the pumping station do not serve the purpose for which they were intended. (*g*) Careful consideration should be given the problem in an attempt to secure the best method for control and use of a tank. In smaller towns the tank should generally float on the lines. In large cities, because the amount of stored water is relatively less, some system of control should be adopted. For cities of moderate size, only through careful study can the method be found that will allow the tank to be used to the best advantage.

Carbon Monoxide Health Hazard From Automobiles

That there is no health hazard in city streets, but danger in both public and private garages from carbon monoxide gas emitted by automobiles and other motor vehicles is the conclusion of a survey made under the direction of H. S. Cumming, surgeon general, U. S. Public Health Survey. From the fourteen cities visited, which had a combined population of more than 19,000,000, 250 samples of air were collected and analyzed. The average of 141 tests assembled from congested city streets at traffic peak hours showed 0.8 p.p. 10,000 of carbon monoxide in the air. Of all the street samples only 24 per cent showed more than 1 p.p. 10,000 of carbon monoxide and in only one location, a covered passageway, was 2 p.p. 10,000 found. Samples taken inside of auto buses showed even lower concentrations of carbon monoxide. In contrast with the low figures for street air, 102 examples collected in 27 garages in the fourteen cities showed an average carbon monoxide content of 2.1 p.p. 10,000. More than four parts was found in 18 per cent of the total number of samples, and more than one part in 59 per cent. All these samples were taken in garages and repair shops of considerable size. The bulletin issued by the Public Health Service indicates that still greater danger exists "in the small private garage containing one or two cars."

A Stream-Flow Sewage-Treatment Process

The Experimental Development of Mechanical Agitation Simulating the Reaeration of Streams—Possibility of Increased Efficiency by Dividing the Treatment Into Biologic Stages

By Harry N. Jenks and Max Levine
Sanitary Engineer and Bacteriologist, respectively,
Engineering Experiment Station, Iowa State College, Ames, Iowa

Efforts to Find a method of aeration in the activated-sludge process that would be simpler, more efficient and less costly than the diffusion of compressed air have been numerous. Thus far they have centered in mechanical agitation, either by paddles or by pumps, and have relied upon taking up oxygen directly from the air instead of introducing it beneath, from air compressors. Surface absorption of oxygen from the air by exposure of sewage in a thin stream—hence the appellation "stream-flow"—has been studied by the authors of the following article and is proposed by them for use as a substitute for bubbling air through sewage. Stream-flow aeration requires, the authors state in a letter, "a relatively inexpensive amount of pumping" and makes possible "a rate of surface exposure proportioned to the actual oxygen demand from the first to the last aeration tank, thus resulting in the minimum expenditure of energy for mechanical aeration." By alternating aeration and settlement in successive tanks, the authors add, "biologic stage treatment may be practiced." —Editor.

During the course of their investigations in the field of industrial waste disposal, the writers originated and studied experimentally a distinctly new means of aeration. When embodied in a sewage-works of special design, the functional action simulates, more closely than that of any existing method, the basic phenomena responsible for the natural self-purification of sewage-polluted streams. It has accordingly seemed appropriate to designate the new design as a stream-flow sewage-treatment plant. Although in its original form it was developed as an improvement in the activated-sludge process, yet subsequent experience, gained through systematic studies both in the laboratory and in the field, has shown that, in practical operation, the stream-flow principle of aeration gives promise of furnishing an improved means of oxidizing organic wastes in general. It may also take the form of a mixing device or be used as a method of precipitating salts from solution by exposure to the atmosphere.

Conception of Stream-Flow Aeration—For some time past the writers, in common with other workers in this field, have been impressed with the evident wastefulness of the present methods of introducing compressed air, through diffuser plates, into the body of sewage passing through the aeration tanks of an activated-sludge plant. By waste of air is meant the use of air for other than its appropriation by the aerobic organisms for the oxidation of the organic matter. That the amount of air, and consequently the expenditure of power, is greatly in excess of the theoretical requirements for the satisfaction of the oxygen demand is clearly indicated by Fig. 1. On this diagram a curve is drawn showing the air supply theoretically required for an industrial sewage having an initial five-day oxygen demand of 1,000 p.p.m, based on the assumption that the rate of satisfaction of this demand will proceed substantially in conformity with the general course of the deoxygenation curve proposed by Phelps and later more fully confirmed by Theriault during the latter's studies on the pollution of the Ohio River.[1] Although deoxygenation in the presence of activated sludge, and the consequent need for oxygen to supply the resulting deficit, may doubtless be found, upon further study, to proceed at numerically different rates than in the ordinary cases considered, yet the writers have determined that the five-day deoxygenation curve, in its typical form, quite well defines the general relative magnitude of the oxygen demand during successive periods of time, measured, in the present instance, in hours of aeration.

As may be seen in Fig. 1, the average theoretical requirement for air, in the case of the industrial waste considered, is only slightly more than ½ cu.ft. per gallon, whereas the normal use of air in practice might be 6 to 8 cu.ft. per gallon. Aside from this wide divergence in the quantities of air involved in the oxidation process, the current practice of supplying the same amount of air per unit volume of sewage from beginning to end of the oxidation period is not in conformity with the fact expressed by Phelps that "the rate of biochemical oxidation of organic matter is proportional to the remaining concentration of unoxidized substance, measured in terms of oxidizability." To take this condition into account requires the introduction of oxygen at the maximum rate at

[1] Phelps, E. B. (1909). "The Disinfection of Sewage and Sewage Filter Effluents." U.S.G.S. Water-Supply Paper 229, pp 74-88.
Theriault, E. J. (1927). "The Oxygen Demand of Polluted Waters." Pub. Health Bulletin 173, p. 131 *et seq.*

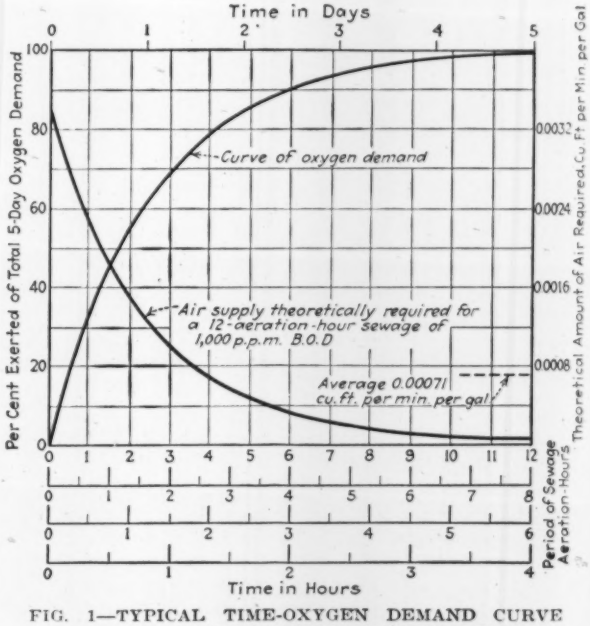

Time in Days
Per Cent Exerted of Total 5-Day Oxygen Demand
Curve of oxygen demand
Air supply theoretically required for a 12-aeration-hour sewage of 1,000 p.p.m. B.O.D
Average 0.00071 cu.ft. per min. per gal.
Theoretical Amount of Air Required, Cu. Ft. per Min. per Gal
Period of Sewage Aeration-Hours
Time in Hours

FIG. 1—TYPICAL TIME-OXYGEN DEMAND CURVE FOR STREAM-FLOW SEWAGE TREATMENT

Probable oxygen requirements determined by superimposing scale for given aeration period. Based on the assumption that the oxygen demand exerted will correspond to the deoxygenation within the foreshortened period of time represented by the total aeration-hours found necessary for practically complete satisfaction.

the beginning of the process, followed by a gradual reduction of air supplied, corresponding to the decreasing oxygen demand exerted, until the completion of the aeration period is reached.

As judged by this basic criterion, it is apparent that in the natural self-purification of streams the direct absorption of atmospheric oxygen without the employment of extraneous mechanical power other than an equivalent small loss of head, coupled with the absorption of such oxygen in proportion to the oxygen deficit only, is a manifestation of the economy of nature which the existing artificial process very imperfectly applies. The theory of reaeration and its application to problems of stream pollution encountered in practice has had extensive treatment in current technical literature, notably by Streeter and Phelps, in a classic contribution to our knowledge of the physical factors involved in the self-purification of streams.[2] The definite, quantitative relationships discovered by these investigators and formulated mathematically for use in computing reaeration rates furnished valuable collateral evidence as to the correctness of the basic conception for the engineering design of a sewage-works on the stream-flow principle, presently to be described. In such a plant the oxygen requirements are met through surface reaeration of the sewage under optimum conditions, as found in natural watercourses.

Engineering Design on Basis of Stream-Flow Reaeration—Holding in review the conclusions set forth by Streeter and his collaborators in regard to stream-flow aeration, it is apparent that this natural phenomenon can be directly applied to the treatment of organic wastes by providing an engineering design in which the maximum value of the reaeration coefficient, K_2, should be obtained, as given by the expression $K_2 = cV^n \div H^2$, where K_2 = coefficient defining the rate of reaeration; V = velocity of the stream in feet per second; H = mean depth of flow in feet; c = constant depending chiefly upon irregularities in different stream stretches, producing turbulence; n = constant defining the variation in reaeration rates in the same river stretch for different flow conditions.

The object just stated may be attained by means of a controlled section of stream channel in which the proper depth and velocity can be maintained. In natural streams, the decomposition of the sewage proceeds over a long course of flow, many miles in length, so that it was recognized that within the physical limits of a treatment plant the necessary time element, in terms of distance traversed, could not be introduced in this way. Accordingly, recirculation of the sewage over the controlled section was decided upon and the engineering design of the plant was made in conformity with the following basic assumptions:

1. The rate of biochemical oxygen satisfaction will proceed in the presence of activated sludge, substantially in agreement with the deoxygenation curve as derived for flowing streams, except that the biochemical oxygen demand will be fully exerted and satisfied within a foreshortened period of time. (See Fig. 1.)

2. The effect of reaeration may be closely simulated by exposing the sewage flow in thin sheets to the atmosphere by recirculation over a reaeration surface comprising a controlled stream section which may be distinctly separate from the zone of biologic activity wherein the oxygen so absorbed is utilized.

3. The rates of recirculation of sewage over the reaeration surfaces at different points throughout the aeration period may be adjusted to the actual biochemical oxygen demand correspondingly exerted.

The physical construction which a stream-flow plant thus assumes was seen to involve essentially a biochemical oxidation zone contained in a tank or basin through which the main body of sewage progresses, and a separate reaeration or oxygen-absorbing zone, embodied in a paved surface adjacent to or above the tank, over which an independent and concomitant recirculation of the organic wastes is maintained. The sewage is withdrawn from the oxidation zone, discharged onto the reaeration surface and allowed to flow down the slope of this surface, thence returning into the oxidation zone within the aeration tank.

In comparing the stream-flow plant design conditions with the relationship $K_2 = cV^n/H^2$, as derived by Streeter, it will be noted that the minimizing effect of H may be practically eliminated by making the depth from 0.5 to 1 in., thus presenting the maximum surface practicable for a given volume of sewage recirculated over the reaeration surface. The desirable velocity of flow over this surface to prevent deposition of sludge was assumed to lie between 2 and 3 ft. per second, which corresponds closely with the range found by Streeter to be conducive of maximum values of the reaeration coefficient K_2. It has also been determined that a slope of ½ in. per foot will give substantially the desired velocity,

[2] Streeter, H. W., and Phelps, E. B. (1925). "A Study of the Pollution and Natural Purification of the Ohio River." Pub. Health Bulletin 146, p. 45 *et seq.*

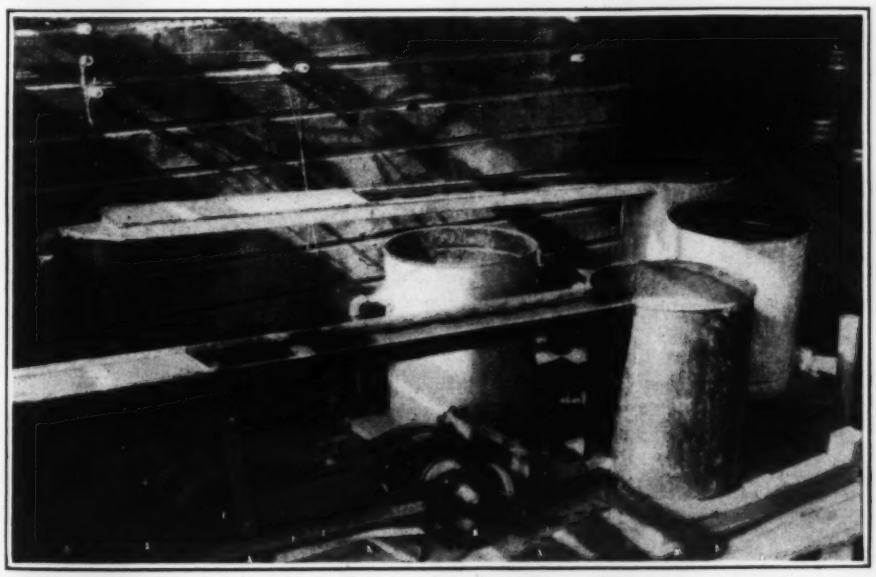


FIG. 2—LABORATORY STREAM-FLOW SEWAGE-TREATMENT PLANT
Showing method of recirculation of sewage over reaeration surfaces. The apparatus is here arranged for biologic stage treatment.

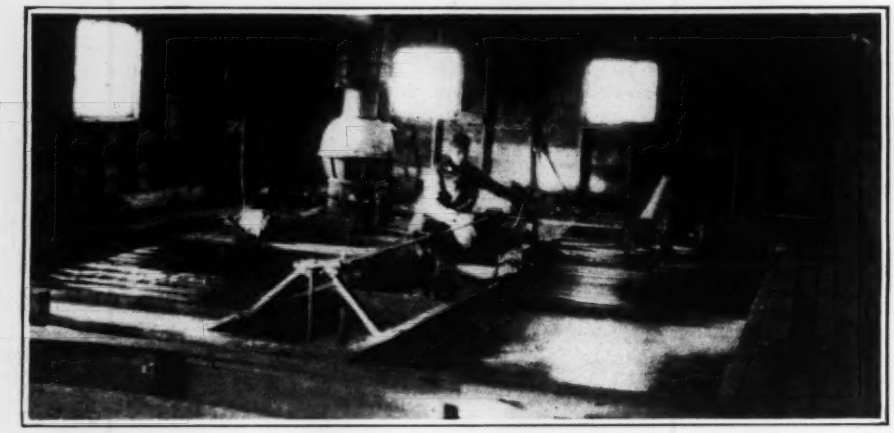


FIG. 3—FIELD INSTALLATION OF STREAM-FLOW PLANT FOR TREATMENT OF PACKING-HOUSE WASTES

Housed in for winter operation. Portion of circular Tank A in immediate foreground. Tanks B and C are seen to the left and right, respectively, of the operator. Note film-like sheet of sewage flowing over the reaeration surfaces and discharging into oxidation tanks.

even when transverse cleats are placed in the reaeration channel to induce riffling. As this slope is greatly in excess of the 2 ft. per mile above which point the value of c increases most rapidly, the effect of such a slope is very favorable to increased values of K_2. Finally, as regards n, in a channel of the type under consideration the hydraulic radius increases rapidly with increased depth, so that the velocity effect itself predominates, with a value of n close to unity; this is also true on account of the negligible effect of the depth H. The conditions of flow, therefore, in a stream-flow plant are the counterpart of a natural stream progressing through a long series of riffles and pools, a condition known to be most favorable to self-purification within a minimum distance, measured in time. In fact, if sufficient difference in elevation exists at the treatment plant site, it is possible to design the plant in such a manner as to obviate a substantial part of the recirculation pumping, through the utilization of this available head. In this case the operation of the plant approaches most nearly the ideal natural conditions for treatment by the stream-flow process.

Installation of Practical-Scale Stream-Flow Plant—After the stream-flow idea had been given a thorough preliminary trial with the laboratory apparatus shown in Fig. 2, operating on milk wastes up to 2 per cent concentration and yielding results presented at a later point in this article, a practical-scale field plant was constructed at the packing plant of the Jacob E. Decker & Sons Company, Mason City, Iowa. Fig. 3 shows the general arrangement of the plant and the types of pumping equipment employed for test purposes. Fig. 4 is a view of the second aeration unit (Tank B, indicated in the flow sheet of Fig. 5), taken to illustrate the realistic manner in which the recirculation of the sewage simulates the rills and riffles of a rapidly flowing, shallow stream.

The structural features of a stream-flow plant, except for the aeration units, conform in essential particulars to the general design followed in the case of the activated-sludge process. That is, a complete installation might comprise preliminary settling tanks or screens, and final sludge settling tanks, together with appurtenances, in addition to the stream-flow aeration units themselves. As there is nothing in the aeration units to become clogged, whatever removal of suspended matter may be effected beforehand will be done to lessen the biochemical oxygen demand of the influent or to remove and recover such organic solids as may be utilized in the by-products department of the industrial plant producing the wastes. The provision of pretreatment by sedimentation or screening thus becomes a matter of economics rather than one of necessity.

Effect of Recirculation on Retention Period—In practice, circumstances will dictate as to the positioning of the inlets and outlets of the various tanks or basins and of the recirculation piping. Because of the removal and return of the sewage as it passes through each of the oxidation tanks or the various compartments of a single tank, it is evident that there will be an indeterminate amount of short circuiting of the tank contents from inlet to outlet. The crude or average retention period is computed on the actual displacement basis, although in fact the aeration period of successive volumes of flow is variable.

The situation with reference to effects of short circuiting may be regarded as analogous to that which prevails in connection with the flowing-through period in mechanically operated mixing tanks. This matter was thoroughly investigated in relation to the design of the coagulation tanks for the Sacramento (Calif.) water-filtration plant under the direction of Charles G. Hyde, chief consulting

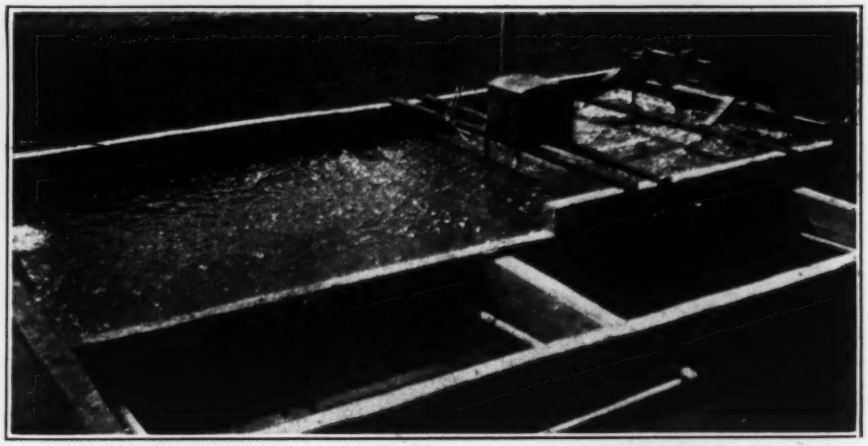


FIG. 4—PRIMARY-STAGE AERATION UNIT OF PRACTICAL-SCALE STREAM-FLOW SEWAGE-TREATMENT PLANT

Illustrating the realistic manner in which the recirculation of the sewage over the reaeration surface (to the right) simulates the rills and riffles of a rapidly flowing, shallow stream. Propeller-blade pumps were used to operate this unit, as shown near the end wall of the structure.

engineer, and based on the original research work of W. F. Langelier. Professor Langelier[3] concluded from experiments that the probable undertreatment due to short circuiting may be expressed by the formula $X = 1 - [1 - (1 - R/Q)^{t/n}]n$, where Q = capacity of each tank in gallons; R = flow of water, gallons per minute; n = number of tanks; t = minutes actual retention in tanks; X = proportion of water remaining in tanks t minutes (or longer).

The foregoing formula is based on the assumption of practically instantaneous diffusion of incoming water with the tank contents. Curves based on this expression show that when there are two or more tanks, short circuiting is greatly reduced, the number of tanks having a much greater effect than their capacity in obviating undertreatment due to this cause. From actual operating experience at the plant mentioned, Jenks found that the proportion of total flow escaping adequate coagulation, or its retention equivalent, is negligible when three or more tanks are operated in series. It is concluded that similar results are to be expected from the aeration units of a stream-flow plant.

Pumping Equipment for Reaeration—The manner of maintaining the auxiliary recirculation of the organic wastes through the reaeration system as the main body of sewage progresses through the oxidation tank is a matter

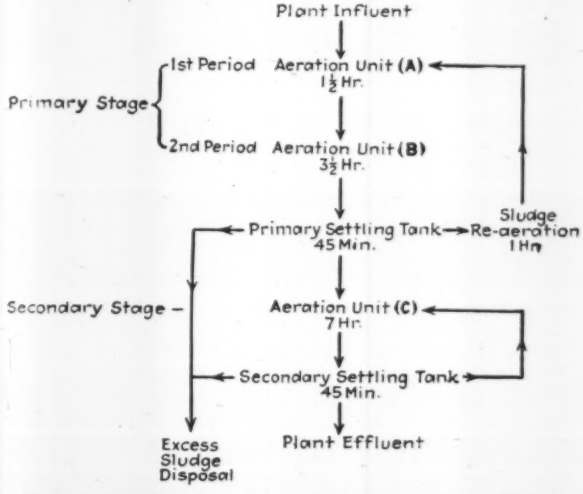


FIG. 5—TYPICAL FLOW SHEET THROUGH STREAM-FLOW SEWAGE-WORKS, EMBODYING BIOLOGIC STAGE TREATMENT

Primary sludge is returned to primary stage after reaeration, and excess is removed without allowing it to enter secondary stage. Secondary sludge is returned to secondary stage and excess combined with primary sludge excess, to be conveyed to point of sludge disposal.

to be decided upon the basis of convenience and cost. It will be recognized that the problem here is a most unusual one, involving as it does the discharge of relatively large volumes of sewage against an extraordinarily low static head, amounting to perhaps not more than 4 to 6 in. It is, however, possible to insure a reasonably high pumping efficiency by so arranging the recirculation system as to pump a less volume of sewage against a proportionately greater head without impairing the efficiency of aeration. Of the standard forms of pumps, the screw pump offers one of the best means of meeting these operating conditions at a reasonable efficiency. Such a pump might, however, be unduly expensive when designed specially for an extremely low head. Accordingly, three special pumping mechanisms, such as might be fabricated in a local machine shop, were devised for the Decker experimental field plant. Tank A was provided with a plow pump, Tank B with a propeller pump and Tank C with a plunger box pump. The general view of the plant, shown in Fig. 3, indicates these devices in

TABLE I—B.O.D. REDUCTION IN PACKING-HOUSE WASTES EFFECTED BY STREAM-FLOW AERATION UNIT

Based on laboratory plant operation from July 14 to Aug. 27, 1927. Results in p.p.m. after five days at 20 deg. C.

Oxygen Demand of Settling Tank Effluent Before and After Treatment				
	——After Aeration Period, Hr——			
Raw Wastes	6	12	18	22
1,000	300	65	60	120
1,180		115	95	90
700	80	40	40	50
1,100	43	18	20	28
820	56	33	33	30
925	44	25	26	26
600	32	98	70	45
650	38	30	30	50
550	52	13	34	
1,225	40	74	79	73
1,300	48	33	27	47
1,050	106	110	28	
2,000	132	69	56	
Median value..... 1,000	50	40	34	55
—Apparent Satisfaction of Initial Demand, Per Cent*—				
	0	95	96	97	94

*After various aeration periods taken on supernatant liquid; actual percentage satisfaction of demand should take into account transfer of oxygen-demanding substances to the activated sludge.

operation. Their suitability for this service is being studied comparatively to determine which design might be used most advantageously. In this connection also an apparatus of unique design is being tested, which might be termed a vortex pump. It is believed that with this device advantage may be taken of the very low lift to utilize effectively the velocity head created by the pump impeller.

Plant Operating Data—The operating results obtained from the stream-flow plant are based on an extensive series of tests with the laboratory-sized apparatus (Fig. 2) on milk wastes, packing house wastes and sugar beet wastes. The satisfactory treatment of these wastes from the standpoint of biochemical oxygen demand reduction, development and maintenance of an excellent activated sludge and elimination of acid-producing constituents led to the design and construction of the field plant as already described. This installation has enabled a study to be made of the mechanical, hydraulic and general engineering features of the new design.

Aeration Efficiency—The efficiency of the stream-flow principle of aeration has been shown to be consistently as good as that of diffused air, when treating the industrial wastes already mentioned. Illustrative of the results obtained on packing-house wastes, Table I is presented, which shows the reduction in biochemical oxygen demand after various aeration periods. The data are based on six weeks' operation and the results are listed in the order of their occurrence. It will be noted that although the wastes being treated may be considered a twelve-aeration-hour sewage, yet a remarkable reduction in B.O.D. occurs after only six hours' aeration.

As to comparative efficiency of stream-flow aeration, it is believed that the continual exposure of the sewage to the atmosphere, as it flows over the reaeration surfaces in thin films, more closely approaches the optimum conditions for oxygen absorption than any design heretofore proposed.

Effect of Biologic Staging—The division of the treatment process into two or more stages, developing and maintaining a distinctly separate activated sludge for each

[3] Langelier, W. F. (1921). "Coagulation of Water With Alum by Prolonged Agitation." *Engineering News-Record*, Vol. 86, No. 22, pp. 924-928, June 2, 1921.

stage, was conceived as a means of favoring increased biologic efficiency on the basis of considerations relating to the biologic zoning of trickling filters. That this reasoning is essentially correct is evidenced in part by the results of stage treatment given in Table II, showing that nitrification was obtained by this means when treating 2 per cent milk waste by stream-flow aeration units. It may be noted that whether a primary stage of six hours was succeeded by a secondary stage of eighteen hours, or the process was reversed, nitrification for this type of waste ensued. In contrast to these results, Levine[4] showed in previous research on the treatment of milk wastes that even with an unlimited supply of diffused air it was impossible to produce nitrates in single-stage treatment by the activated-sludge process.

Although the writers are aware that some engineers may be of the opinion that stage treatment does not commend itself on economic grounds for domestic sewage, yet they are convinced that biologic stage treatment merits serious consideration as an important aid in enhancing the efficiency of the activated-sludge process where the more concentrated industrial wastes are concerned. This conception of the logical and proper method of operating an activated-sludge plant is being given further study in the field stream-flow plant at Mason City.

TABLE II—CHANGES IN NITROGENOUS CONSTITUENTS OBTAINED BY AERATING 2 PER CENT SKIM-MILK

	Aeration by Diffused Air*		Stream-Flow Aeration†				
Constituent	Raw Waste	Effluent After 21 to 45-Hr. Aeration	Raw Waste	23-Hr. Continuous Aeration	6-Hr. Primary 18-Hr. Secondary	18-Hr. Primary 6-Hr. Secondary	6-Hr. Primary 6-Hr. Secondary
Org. N	102.5	9.08	72.6	19.7	7.55	10.65	11.25
NH_3	1.70	12.70	1.4	0.35	13.12	12.08	1.75
NO_2	0.05	0.01	0.044	0.01	5.38	5.07	3.8
NO_3	1.38	0.12	1.38	0.50	2.39	2.03	2.6

*From May 15 to June 7, 1922. See Iowa Engineering Experiment Station Bulletin 68, p. 27.

†Raw wastes, May 31 to July 5, 1927. Aerated wastes, all in 1927, as follows: 23-hr. continuous aeration, May 31 to June 2; 6-hr. primary followed by 18-hr. secondary, June 5 to 24; 18-hr. primary followed by 6-hr. secondary, June 5 to 24; 6-hr. primary followed by 6-hr. secondary, June 28 to July 5.

It appears that at least one important point that has heretofore not been adequately emphasized is the great advantage of removing as quickly as possible from the aeration tanks all excess sludge with its own high oxygen-demanding characteristics gained by adsorption from the wastes being treated. This can be accomplished by intermediate settling between stages and so lessen the oxygen demand of succeeding stages. To take advantage of this fact, the Decker practical-scale stream-flow plant provides stage treatment in accordance with the flow sheet shown in Fig. 5.

Power Requirements for Stream-Flow Aeration—It can be shown by computations based on the deoxygenation curve described in a previous section of this article and corroborated substantially by experiments that a packing-house waste such as that found at the Decker plant and referred to in Table I can be treated by the stream-flow method through twelve hours' aeration, involving the recirculation of approximately 125 times the volume of sewage flow. Similar methods of computation applied to the case of a strong domestic sewage having a B.O.D. of 350 p.p.m. should be successfully treated through six hours' stream-flow aeration of 50 times the volume of flow. For the latter case, assuming a lift of 4 in. and, conservatively, an over-all pumping efficiency of 25 per cent, water level to water level, the required energy for aeration should not exceed 12 hp. per m.g.d. treated.

It is realized that only actual operating experience with a full-sized installation can demonstrate the correctness of such a power estimate. Yet the order of magnitude of the power required is such that a considerable factor of safety might be further introduced without seriously detracting from the favorable comparison that can be drawn between the stream-flow plant and existing means of sewage aeration.

Cost of Construction—In the construction of a stream-flow plant, it will be observed that it may be built so as to require relatively little excavation. In general, if excavation costs are high in comparison with the cost of the land covered by the plant, then the tanks may be made quite shallow. For small plants, it is suggested that the depth may be 4 to 6 ft. No dependence upon depth is required to provide a proper contact period of the air with the organic matter, which is a practical necessity in the diffused-air activated-sludge aeration tank. On the other hand, if the oxidation tanks are made of conventional depth, then the stream-flow aeration units will occupy very closely the same area as aeration tanks designed in the ordinary way.

The stream-flow absorption of atmospheric oxygen insures an adequate oxygen supply without any expense for installation and operation of air piping and diffuser plates. Also in comparison with air-washing and air-compressing equipment and machinery used in diffused-air plants, the extremely low-head pumping equipment and simple piping alone needed in the stream-flow plant is far less expensive, both in first cost and in operation.

The reaeration surfaces may partly cover the aeration tank or be laid as a pavement on natural ground along the edge of the structure. Experiments indicate that these surfaces should be from 6 to 10 ft. in length, providing three to five seconds' exposure of the sewage film to the atmosphere each time the sewage flows over the pavement. A design factor will be determined empirically which will give the permissible recirculation rate in g.p.m. per sq.ft. of reaeration surface. If required by severe weather conditions, the reaeration surfaces may be readily covered, air being admitted through suitably spaced ventilators.

Acknowledgments and Conclusion—The stream-flow sewage works design and studies described in this article are an outgrowth of a program of research made possible through an agreement, effected during March, 1927, between Jacob E. Decker & Sons, of Mason City, Iowa, and the Engineering Experiment Station, Iowa State College, whereby a co-operative industrial fellowship was established for conducting packing-house waste-disposal investigations at the Decker plant. The writers assumed active charge of the project, to collaborate in the solution of the biological and sanitary engineering problems that presented themselves. Frederick G. Nelson, sanitary engineering graduate of the University of California, was appointed resarch fellow, in charge of field work at Mason City. Dean Anson Marston, as director of the Engineering Experiment Station, has general supervision of all projects undertaken by the station.

It gives the writers pleasure to acknowledge at this time the very gratifying co-operation of the Jacob E. Decker & Sons organization, particularly on the part of Jay E. Decker, president, E. S. Selby, treasurer, and Elmer E. Dye, chemist of that company. Acknowledgment is also due all members of the Engineering Experiment Station staff who have been interested in the furtherance of this

*Levine, Max; Soppeland, Lulu, and Burke, G. W. (1923). "Aeration Studies on Creamery Waste Purification." Iowa Eng. Exp. Station Bulletin 68, pp. 26-27; p. 38.

project, among whom Harry E. Goresline, assistant bacteriologist, and George W. Burke, chemical engineer, have rendered valuable assistance in the laboratory work.

It is not possible, within the scope of this article, to review the results obtained by other investigators in the field of sewage aeration by mechanical agitation, in order to point out the essential similarities and differences between stream-flow aeration and that secured by other means. It is the writers' hope that after they and others who will become interested in this subject have fully overcome the difficulties that will naturally be encountered in the practical application of so novel a form of sewage-treatment plant, it will become a fitting engineering counterpart of the notable advances made by British engineers in the use of mechanical aeration in the activated-sludge process.

Earth Fill and Wood Seats Give Low-Cost Stadium

Stands for Colorado State Teachers College Built on Embankment Made From Earth Got in Grading Football Field

By L. L. Stimson
Consulting Engineer, Greeley, Colo.

APPLYING the railroad grading practice of making fills from cuts, a stadium has been constructed at low cost for the Colorado State Teachers College at Greeley, Colo. To level off the football field required the removal of 13,000 cu.yd. of earth. By adding this excavated material to a natural ground rise on the west side and on the north and south ends of the field, an embankment was built up, 14 ft. above the field level. This fill, 1,000 ft. long, has a top width of 10 ft., an inside slope of 1 on 3 and an outside slope of 1 on 1½. Wood steps and seats placed on concrete piers running up and down the fill comprise a very economical seating arrangement.

The embankment was built up very carefully to provide against settlement. Dump wagons, loaded by an elevating grader, dumped the spoil in windrows, spaced so that when leveled they made a layer about 10 in. thick. All leveling was done by disk harrows without rolling, as the dump wagons compacted the earth sufficiently. Sprinkling was resorted to whenever the material became very dry. The inside face of the fill was slightly overfilled and then trimmed to secure a true surface for placing the seats. The embankment has stood up under two years of severe weather without settlement.

As shown by Fig. 1, the wood seats and steps are placed on concrete piers or ribs, 8 in. wide, running up and down the slope, spaced 6 ft. on centers on the straight portion and radial to the curves at the ends of the field. Each pier consists of the rib proper, set 4 in. into the earth; the pedestals and supports for the seats, and the runways, aisles and posts. All are poured in one piece. Reinforcing was placed as shown. Bolts for fastening all timber to the concrete were placed by templets before pouring the concrete. The pier forms were used in sets of six, each set being used fourteen times. The concrete was a 1:4½ mix of pit-run gravel, poured as wet as possible for easy handling.

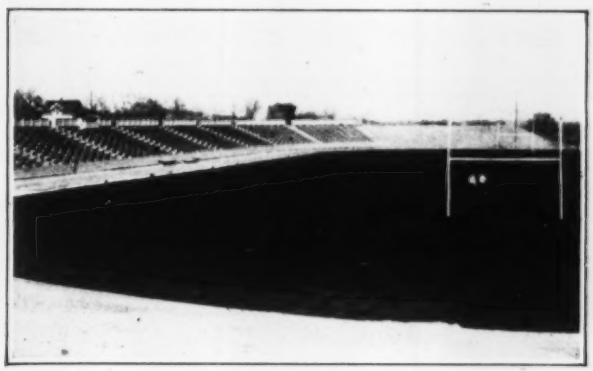


FIG. 2—VIEW OF COMPLETED STAND AND FIELD

All seats and runways are built of 3-in. Oregon fir, painted with lead and oil before placing. The risers are 2-in. fir, also painted. The risers and runways rest directly on the concrete piers, while the seats are fastened to 3-in. wooden studs bolted to the sides of the piers. All nuts are countersunk flush and the holes filled with hot sand and asphalt mastic.

A wood wall at the top of the stands and a railing at the bottom complete the structure. The solid top wall shuts out part of the sweeping winds that usually prevail in this section. Seats for 5,000 persons have been provided, but there is room for an additional 3,000 seats on the present embankment.

Access to the stands from the street level is through three stairways 12 ft. wide, over the top of the embankment. A 10-ft. gravel walk covers the entire top. The stairs are built like the seats, on concrete ribs, and have galvanized-iron pipe railings.

If the paint is renewed occasionally on the wearing surfaces, there is no reason why the structure described

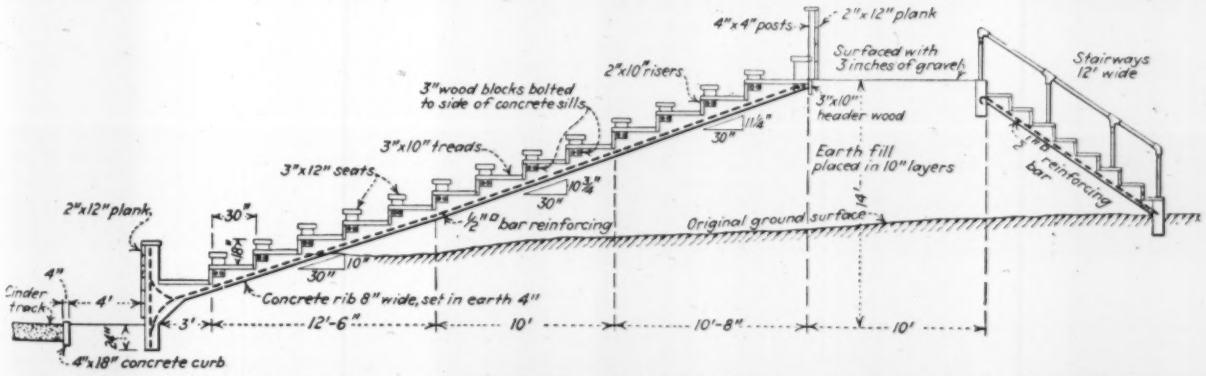


FIG. 1—SECTION OF STANDS AT CONCRETE PIERS, COLORADO STATE TEACHERS COLLEGE STADIUM

cannot be considered permanent in the dry climate of eastern Colorado. Erosion on the back side of the fill is prevented by creeping vines, which also add to the beauty of the surrounding grounds. This type of stadium is very satisfactory for small schools of limited means, especially in arid or semi-arid country. Placing the seats on low piers on a sloping embankment is also the safest method possible.

The following is the cost of the work, obtained from the official records of the college:

Concrete piers	$1,818.00
Timber in place	4,307.54
Engineering	400.00
Total	$6,525.54

This gives the cost of $1.305 per seat. The cost of grading the field and placing the embankment was $4,000. This is not entered as part of the cost of the stand, as the grading of the field was necessary regardless of the type of stand used.

All earth work was done by Bedford & Welsh, and the concrete and timber work by William Welsh. Engineering and supervision were handled by the author and R. G. Dempsey, superintendent of grounds for the Colorado State Teachers College.

Transmission Tower With Rotating Crossarm Developed

Designed to Minimize Trouble From Broken Wires by Effectively Relieving Tension on Tower and Keeping Wire in Clamp After Break

TESTS made on an experimental transmission tower line using a rotating crossarm tower have indicated a number of advantages for such a tower. As interpreted by the engineers of the Riter-Conley Company, Pittsburgh, who made the tests, these advantages are that

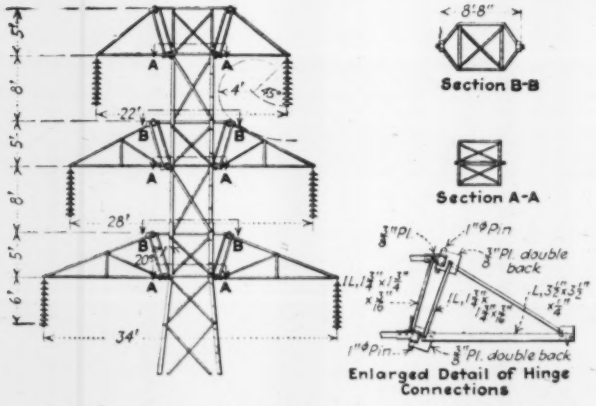


FIG. 1—DETAILS OF ROTATING CROSSARM TOWER

(1) such a transmission line will effect considerable saving in steel; (2) the towers are resilient against stresses produced by broken conductors; (3) the towers present no difficulty against stringing conductors; (4) a broken wire usually remains in position in the clamp and thus simplifies the operation of re-sagging the wire; (5) the rotating crossarms will operate under any sleet conditions, whereas slipping clamps often do not; (6) rotating crossarms will rotate slightly to relieve unbalanced tensions; (7) as the arm rotates it carries the wire toward the central axis of the tower, thereby reducing the torque stresses in the tower.

The swinging crossarm tower has the appearance of a regular double-circuit tower, except that the crossarms are hinged at a point close to the body of the tower. The axis of the hinge is inclined from the vertical and so designed that when a wire breaks, the crossarm will swing into the direction of the line, adding its length as well as that of the string of insulators to the length of the wire, materially reducing the tension in the wire. The axis of rotation is inclined upward, a detail that is

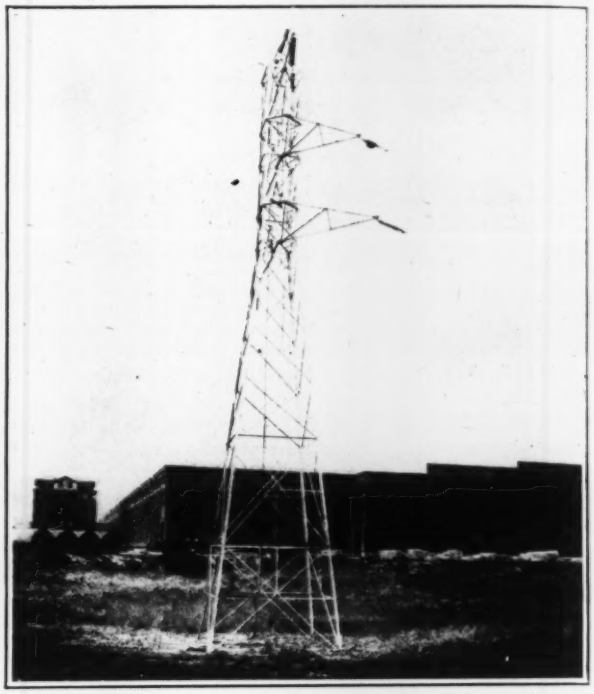


FIG. 2—ROTATING CROSSARM TOWER WITH MIDDLE AND BOTTOM WIRES BROKEN

said to produce a dampening effect upon the revolving arm, since the wire must move upward and thus raise the weight of the wire and insulators.

In the test transmission line, following the breaking of a wire, crossarms on the first tower rotated 90 deg., those on the second tower about 80 deg., those on the third tower about 60 deg., those on the fourth tower about 30 deg. and those on the fifth tower about 10 deg., showing that the effect of a broken wire was practically dissipated in five towers.

The test towers were designed for a condition of only one broken wire and an assumed tension of about 4,000 lb. with 50 per cent overload. Each of these towers weighed 7,750 lb., and the set of grillage footings weighed 1,650 lb., making a total weight of 9,400 lb. While the saving in all cases will depend upon the loading conditions and will be small for light construction and large for heavy construction, the engineers believe that the test towers effected a saving of about 20 per cent in weight over towers with rigid crossarms.

In all lines where such rotating crossarms are used, rigid crossarm construction will still be necessary at strain positions and at points of large angularity.

Building Houston's Great Convention Hall

Design and Construction of 85,000 Sq.Ft. of Lamella or Woven-Wood Arch Roof—Structure Built to Seat 20,000 Persons Completed in Record Time

THE AUDITORIUM that has been built to house the Democratic national convention in Houston, Tex., in June involves interesting structural details. It is built entirely of wood, and the roofs are of the so-called "lamella" type, consisting of a diamond-shaped or lattice network of diagonal members built up of planks on edge, to form a woven-wood arch. Work was started on the superstructure on March 12, and the entire building with sheathing on was ready for the roofing paper on April 7.

The building covers 80,000 sq.ft. of floor space and has seating capacity for 20,000 persons. It is shown under construction in Fig. 1. In Fig. 3 are given some of the structural details of the framework. There is a central span of 120 ft. with a height of 57 ft. above the floor, flanked by side spans of 76 ft. with a height of 42 ft. above the floor. The center span is 326 ft. long, whereas the side spans are 265 ft. in length. On each end of the building are small areas covered with flat roofs. Important features with regard to the building's use as an auditorium are the unobstructed view it offers spectators (there are only twelve columns in the interior) and the special provisions for ventilation, which include circulating fans and 3,900 sq.ft. of typhoon space in the roofs.

Type of Construction—The building, viewed structurally, consists only of the lamella-type roof, for this with its supports constitutes the entire framework.

Lamella construction was introduced into the United States from Europe about three years ago. The lamellas are standardized pieces of lumber curved on one side and beveled on both ends. (Fig. 3.) The lamellas for one roof are all of one size. There are right and left lamellas, and all are drilled at the ends and at the center. The roof is constructed by bolting the lamellas together by steel bolts protected by special spring washers. (Fig. 3.) The joints permit simple erection and are claimed to adjust themselves to all possible shrinkage. It is said that clear spans of 130 ft. have been constructed. Although the Houston auditorium is of a flat segmental type in which the thrust is taken by tie rods, other types of arch have been built. For instance, there is the segmental arch roof in which the thrust is taken by buttresses, concrete piers or wooden bents, the Gothic arch in which the lamella construction can start at the ground, and the circular roof used under conditions where some particular architectural effect is desired.

Design Considerations—In designing the convention hall the engineer was governed by certain basic requirements: The size was to be approximately 325 ft. long by 270 ft. wide; the cost was to be as low as possible; a design was to be used that could be quickly erected from stock materials; the height of the springing line at the sides was governed by a clearance above the highest row of seats, while the height in the center was to be as great as possible in order to provide for sufficient air circulation.

FIG. 2—WOVEN-WOOD ROOF, CENTER SPAN, DEMOCRATIC CONVENTION HALL
Houston business district and Rice Hotel in background.

The lamella-type roof having been chosen, the requirements that the cost be as low as possible and that the

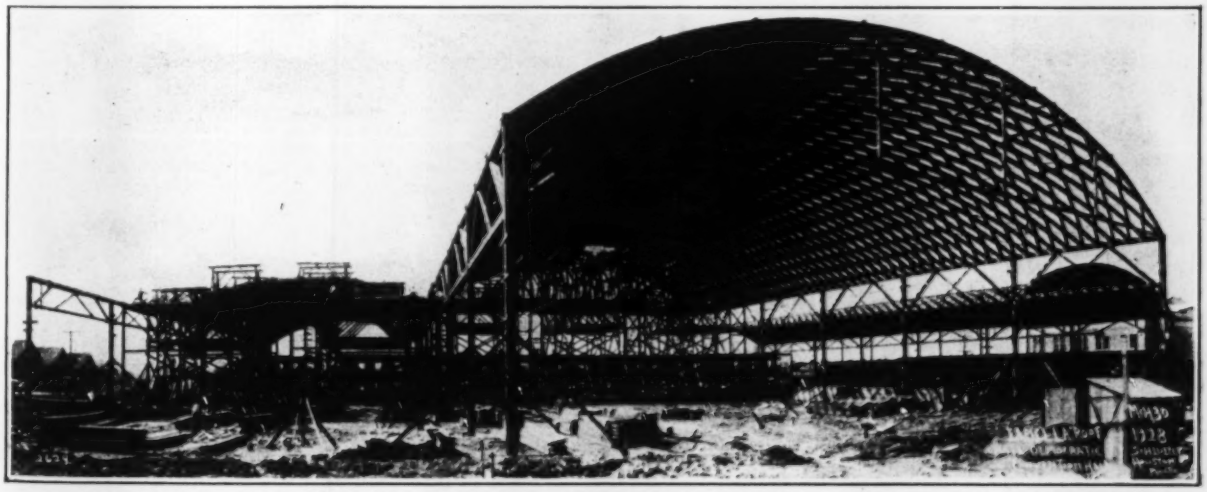


FIG. 1—THE HOUSTON AUDITORIUM FOR THE DEMOCRATIC NATIONAL CONVENTION UNDER CONSTRUCTION

roof be erected from stock material made it necessary to divide the width of the building into three sections. From an engineering point of view it would have been most economical to use three sections of equal span, but these did not provide the desired architectural effect, which contemplated a center span of large dimension. The center span was limited to 120 ft., since the largest size of material in stock was 3x14 in. This left two side bays of 76 ft. each, which could be covered with 2x10-in. lamellas.

It was necessary to provide two rows of columns in the interior of the building to carry the arches; the use of heavy longitudinal trusses made possible a column spacing of 40½ ft. By raising the springing line of the center arch about 8 ft. above that of the side arches, the top chords of the longitudinal trusses were used as base plates for the center arch and the bottom chords as base plates for the side arches. The vertical wall space of the trusses was left open in order to aid in the circulation of air inside the building. The chords for the center span are 14x14-in. timbers and for the side spans 10x12-in. timbers. Inasmuch as the springing line of the roof was too high to provide for the use of outside bent construction strong enough to take the thrust, tie rods were provided at the columns as well as at two intermediate points on each panel, giving a tie rod spacing of about 13 ft. 8 in.

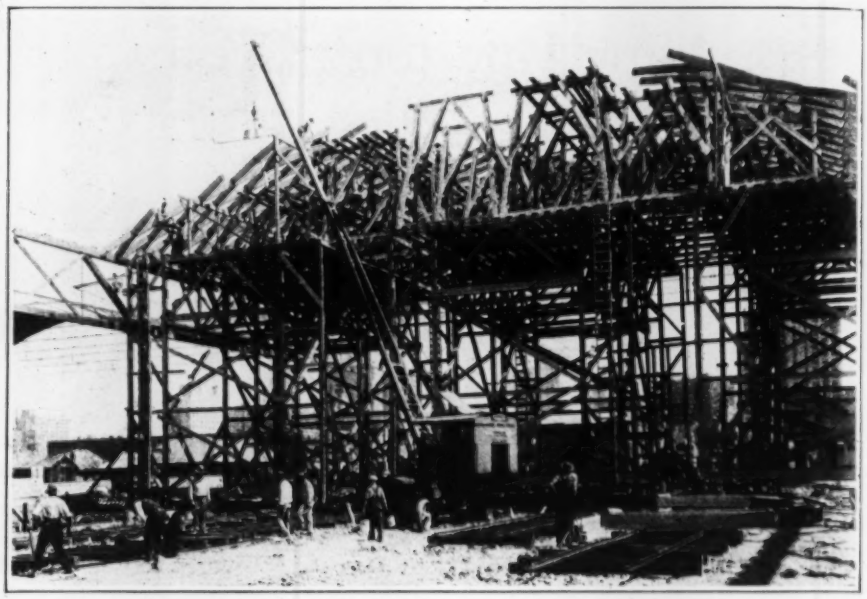


FIG. 4—ERECTING THE MAIN ARCH ROOF—HOUSTON AUDITORIUM
Three travelers 30x50 ft. in plan carried wooden horses which supported the roof for the center span. Two similar travelers were used on each side span. A truck crane with rear crawlers and a 55-ft. boom raised all roof material.

The roof is designed for its dead load plus an unsymmetrical live load of 16 lb. per sq.ft. It is also designed strong enough to withstand a uniform live load of 30 lb. per sq.ft. Since snow loads cannot occur, special consideration was given to wind loads. In the longitudinal direction of the roof the wind pressure is taken by the four rows of columns connected by the longitudinal trusses. The wind pressure upon the sides is resisted by

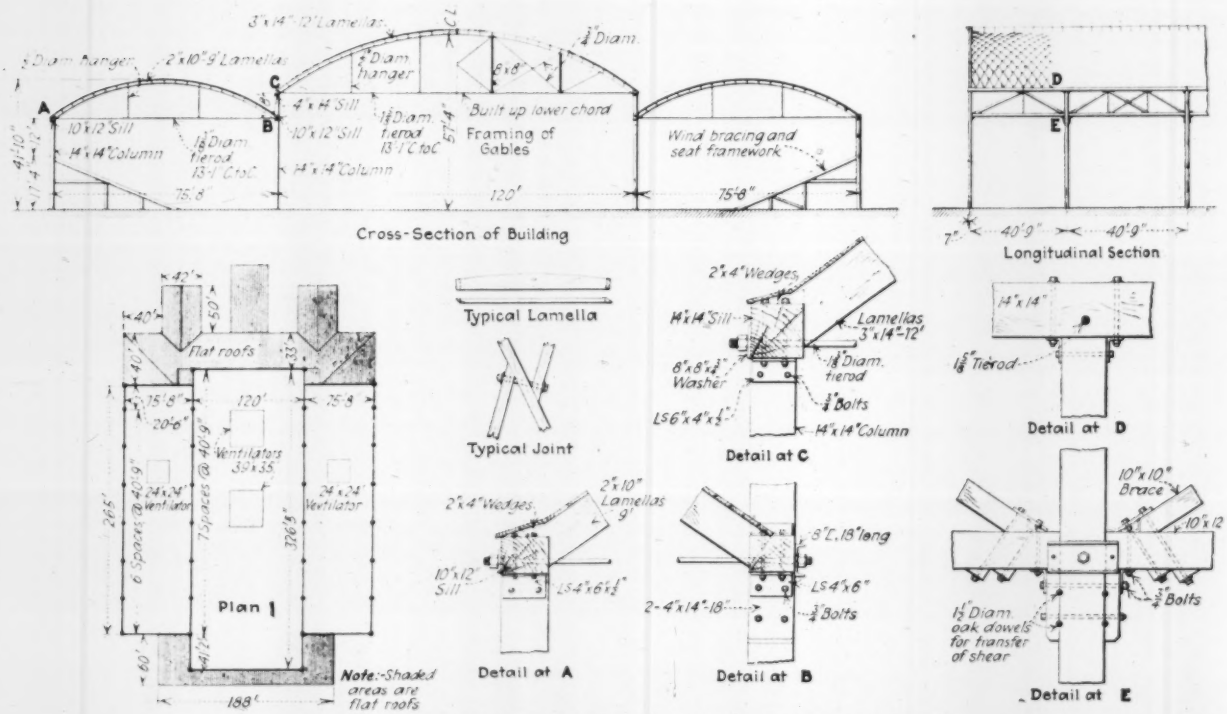


FIG. 3—STRUCTURAL DETAILS OF THE HOUSTON AUDITORIUM
Lamella type of roof used, requiring 2,060 pieces of 3x14-in. lumber 12 ft. long for center span and 1,864 pieces 2x10 in. by 9 ft. long for each side span. Note that center arch springs from top chords and side arches from bottom chords of wall trusses.

the two exterior rows of columns, which are braced for about two-thirds of their height by special connection with the seat framing.

Structurally the roof is a two-hinged arch, and the stresses were computed in accordance with rules and formulas for this type of design.

Construction Procedure — Movable scaffolding was used for all three spans. The scaffolding consisted of two travelers for each side span and three travelers for the center span, each traveler operating on two standard-gage railway tracks. Each traveler was 50 ft. long and 30 ft. wide and was built up to the springing line of the arch, where it was provided with a plank platform. The heights of the travelers were 42 ft. for the main span and 34 ft. for the side spans. Movable wooden horses were used on top of the traveler platforms to provide scaffolding between the springing line and the roof line.

Construction started at one end of the side bays with two travelers. Two movements were made on each working day, so that a total of 100 ft. of arch was completed daily. For the center span only one movement of the three travelers per day was possible; thus this arch was completed at the rate of 50 ft. daily.

The lamellas for the center span were 3x14 in. and 12 ft. long. Each lamella weighed 150 lb. There were 2,000 lamellas needed for the center span and 1,864 lamellas, 2x10 in. by 9 ft. long, used in each side span. All material was hoisted to the roof by a rear-crawler-mounted truck crane. By means of an 8x8-in. timber the boom was extended to 55 ft. so as to reach the highest point of the roof.

It was of the utmost importance that the roof be finished within the specified time. Arrangements for the erection of the roof construction were prepared and executed with such precision that the entire 85,000 sq.ft. was completed eighteen days ahead of contract date and within 27 days after receipt of the order. It took nine working days to erect the lamella construction. Although the use of movable scaffolding is not the most economical method by which lamella construction can be done, it was adopted in this instance for reasons of speed and safety. When scaffolding is not used, one of the two end arches is placed on rollers and moved on the sills on top of the side walls. While it is being moved the lamellas are woven into the finished part of the construction. Such a method requires slightly more time than the method used in Houston and would have meant more hazard for the men who had to weave the heavy lamellas at the considerable height above the ground.

Personnel—The convention hall was designed by Kenneth Franzheim, architect, New York, and W. A. Dowdy, city architect of Houston. The roof was designed by W. Klingenberg, chief engineer, Lamella Roof Syndicate, New York City, and George L. Kelly, chief engineer, Lamella Trussless Roof Company, Houston, Tex. Actual construction was under the supervision of Robert J. Cummins, consulting engineer, Houston. The general contractor was the Universal Construction Company, Houston. A. C. Finn, architect, Houston, acted in an advisory capacity.

South American International Highway Planned

The construction of an international highway to connect Montevideo with Rio de Janeiro, Brazil, was proposed in the recent arrangements for the settlement of the balance of the Uruguayan debt to Brazil.

Some Recent Points Decided in Engineering Law

REVIEWED BY HERBERT BRAASCH
Attorney-at-Law

THESE PARAGRAPHS contain the meat of some current court rulings on cases arising in the business of civil engineering and construction. Cases are taken only from the higher federal courts and from the state supreme courts. Mr. Braasch has reduced legal terminology to a minimum. While each case is presented in as brief space as possible, it is also designed to cover all the points essential to an understanding of the factors involved. Other "Recent Points Decided in Engineering Law" will be published from time to time. —EDITOR.

Arbitration Contracts and Awards

An agreement to arbitrate differences arising out of a construction project binds the parties making it to all its terms, including one limiting time within which the arbitrators shall make an award. On expiration of that time a party is within his rights in giving notice that he terminates the power of arbitrators to act, and their award immediately thereafter is void.—*Willis Finance & Construction Company vs. Porter, California.*

Payments Made Without Legal Obligation

On a project in which some of the material men did not file liens within the required time, but the owner paid them, the owner could not obtain payment from the surety company on the contractor's bond.—*Fuqua vs. Tulsa Masonic Building Association, Oklahoma.*

Oral Modification of Written Agreements

A written contract called for the furnishing of materials and construction of two steamboat hulls of best open-hearth steel; completion within 5½ and 6½ months; partial payments to be made on monthly estimates to be submitted. At the end of six months the buyer ordered work stopped, neither hull being completed. The contractor sued for damages.

Bessemer steel was used instead of open-hearth as specified. This ordinarily would defeat the contractor's recovery. However, he claimed a later oral modification of the contract permitted him to use bessemer steel because the other was unobtainable.

A written contract cannot be modified or varied by an inconsistent oral understanding of the same or prior date, but an agreement of a later date supplants the former contract and may do so though the former is in writing and the later one oral. That such an understanding was agreed to must be proved by the contractor asserting it.

The buyer intended these hulls for parties in South America who the buyer learned would be unable to pay for them, and he gave this reason for having the work stopped. At the trial the buyer defended that the work was not done in the specified time.

Assuming time as of the essence of the contract, the buyer's knowledge from the estimates that the work was far behind and his expressions of regret at different times instead of demands that the work be finished on time may be a waiver of strict compliance and a jury properly so found. Having allowed the stated time to elapse, neither party could suddenly terminate the contract.

The amount recovered as damages included overhead

charges in addition to the labor actually performed and the profit that would have accrued from the transaction. Upon rescission of a contract the contractor has the duty of minimizing damages and cannot recover for what he spends thereafter. He is entitled to what he has already spent plus what his profits would have been.—*Dravo Contracting Company vs. James Rees & Sons, Pennsylvania.*

Contractor's Bond—Liens

There is a decided relationship between the law governing the establishing of mechanics' or material men's liens and the law fixing liability on the bonds of a contractor engaged in public work, but the statutes have different objects and the bond is not restricted to what would give a lien. Gasoline furnished a sub-contractor used as fuel in highway work created a liability under a bond, whereas it would not have given rise to a lien.—*Eagle Oil Company vs. Aultman, Oklahoma.*

No Recovery for Improperly Authorized Highway Work

Highway construction work was awarded by a county under certain plans and specifications, giving length, width, materials, etc. A clause was included providing for payment equal to the cost of labor plus 15 per cent and cost of materials plus 10 per cent on all extra work ordered by the county road engineer.

While work was in progress the contractor was notified by the road engineer that he was having the road widened to state standards [from 18 to 24 ft.]. The engineer so staked out the road and it was completed and accepted, but the county refused to pay for the extra 6 ft., claiming the engineer acted without authority and the order was to that extent not binding on the county. This was not a minor change or addition of the type intended by the contract, but is in the same class as making a new contract or increasing or decreasing the magnitude of the project and can be made only by the authority that awarded the original contract.

The contractor pointed out that the county made no objection to the progress of the road work and is receiving the benefit of it and therefore should not be allowed to dispute the county road engineer's authority. That rule would be applied were the work done for an individual, but persons dealing with municipalities must take notice of the limitation placed upon the agents' authority, and deal with them at their peril.

If the extra material could be removed without injury to the rest of the road, the contractor probably could remove it if he chose.—*Pike County vs. Waugh, Kentucky.*

Lateral Support and Trespass in Building

The general contractor for the erection of a theater sublet the excavation and foundation work. By his contract with the owner responsibility for all injuries (including impairment of lateral support) to adjoining land was assumed by the general contractor. The sub-contractor made excavations and removed lateral supports, causing some of the foundation of the abutting structure to give way. The owner of this building sued the general contractor.

Adjacent owners are entitled to lateral support, and excavation impairing this creates a duty to provide an artificial equivalent. The support supplied need only be such as the land would require in its natural state, liability ceasing if the weight of buildings or other improvements is not carried by proper foundations resulting in a lateral pressure being exerted. The claim was valid by this test.

A land owner cannot relieve himself of these duties by contracting with another party to assume them; likewise the one injured has no rights under such a contract if he were not a party to it, though the damage is exactly what the contract contemplated. For this reason the suit against the general contractor was dismissed.

The sub-contractor is liable to the injured party, because he did the damage, and if he had been the agent or servant of the general contractor, such contractor would then have been directly liable.

In pouring the foundations, forms were placed only on the excavation side and the resulting foundation projected irregularly several feet into the subsoil of the abutting property. This constituted a trespass for which again the sub-contractor was liable to the adjoining owner and the general contractor was not.

The damaged owner would have a good case against the owner of the theater site, and when he recovered the theater site owner could then recoup against the general contractor under their agreement.—*Wahl vs. Kelly, Wisconsin.*

Treatment of Industrial Wastes in Wisconsin

Nine treatment plants of the chemical precipitation type were installed at Wisconsin canneries during 1927, according to a report by the State Board of Health. Both the National and the Wisconsin canners' associations furnished chemists for the studies of operation and the development of control technique. The results were satisfactory in general, but indicated the need of modifications in design and of better understanding of operation on the part of the canners, as well as the possibility of secondary treatment in some cases. As to pulp and paper mill wastes, a survey of all the mills in the state was made to ascertain what steps had been taken in reducing objectionable fibrous and chemical wastes to a minimum. In most of the mills effort was being made to reduce white water wastes to a minimum, through the installation of new save-all and recirculation systems. In some mills the fibrous wastes have become a practically negligible quantity. Research work started during 1927 is being conducted by the mills in co-operation with the state with regard to both the characteristics and the utilization of various chemical wastes.

City Managers Under Ohio Home Rule Charter

Of 26 Ohio cities and villages that have adopted home rule charters, according to information given in *Greater Cleveland*, eighteen have city managers, three of these being in four villages that have adopted home rule charters. A city manager charter is being framed for Toledo. Although the home rule charter possibility has been available for a considerable number of years, only 22 of the 93 cities and four of the 729 villages (municipalities under 5,000) have availed themselves of the privilege. All the other cities and villages are operated under the city or the village type of charter enacted by the legislature after the laws governing the formation of cities in Ohio were declared unconstitutional some years ago because of the extreme use of evasion of the constitutional prohibition against special legislation of cities.

Designing the Towers of the Hudson River Bridge

How Their Indeterminate Framework Was Analyzed—Check by Strain-Gage Measurements on Models —Studies of Effect of Extreme Variations in Adopted Design

By Leon S. Moisseiff
Advisory Engineer of Design, Port of New York Authority

THE TOWERS of the Hudson River suspension bridge are to be masonry-incased steel frames, their completed appearance being largely dictated by esthetic considerations. In an article on the design of the bridge (*Engineering News-Record*, Aug. 11, 1927, p. 212), details of the towers, including the method of support of the two twin cables, are illustrated and described. Much criticism has been directed toward the design of such a composite tower, but repeated studies have led to the retention of the original design, with one major change. Whereas it had been intended that the steel should carry the loads of the first construction stages (half roadway capacity), and the incasement of concrete and stone the added second-stage loads, the adopted design provides that the steel towers be proportioned for the total live and dead loads of the bridge as built to full ultimate capacity. The incasement is regarded as weather protection and a means of increasing the safety factor. This article, slightly condensed from the form in which it was presented to the Structural Division of the American Society of Civil Engineers, describes the analytical and model studies of the towers, which confirmed the rigidity and safety of the adopted design.

—Editor.

THE STEEL towers of the Hudson River bridge in New York City being built by the Port of New York Authority deserve attention because of their great height (600 ft.), their strength, their large tonnage (20,000 tons each) and their special design. In reaching a conception of the forces acting on the towers, it should be remembered that we deal with a bridge of an enormous span (3,500 ft.) and that the dead load of the bridge alone is 39,000 lb. per linear foot, while the live load is but 8,000 lb., a ratio of nearly 5 to 1. The vertical reaction on top of each tower is 112,000 tons and the horizontal pull is 110,000 tons for both pairs of cables. The design includes skeleton towers of braced steel, proportioned to sustain the entire load of the bridge and subsequently to be incased in stone-faced concrete.

The adopted design of the towers permits proportioning the parts within the limits of prevailing shop practice and affords a stable, rigid structure, readily erected. At the same time it lends itself to inclosing and embedding in concrete. The heaviest piece in the tower has a cross-sectional area of 855 sq.in. and weighs 70 tons. The complete skeleton tower consists of four rigidly connected frames, each made of two pairs of braced posts connected by portal bracing into a unit frame.

Following the disposition customary in smaller structures, the two parallel cables on each side of the cross-section would be placed at mid-distance between the tower posts. These posts are 38 ft. c. to c. on top and the central planes of the cables would thus become 144 ft. apart, which would require floorbeams of the same length. The advantage of this disposition would be the central location of the vertical cable reaction in the tower bent and the assumed concentric distribution in each tower leg. Its disadvantage is the very considerable additional cost as compared with the adopted design, which located the cables directly on the inner posts of the towers. This shortened the floorbeams to 106 ft. and, compared with the concentric disposition, saved 12,000 tons of floorbeam material. Allowing for the increased amount of wire to sustain the additional weight and estimating the total increase at contract prices, an additional cost of $2,800,000 would be incurred by placing the cables on the center line of the towers. The effect on the anchorage has been ignored, which would add still more to this sum. The tower itself would show, however, a saving due to its symmetry of less than $100,000. These figures will suffice to demonstrate the efficiency and economy of the adopted design.

The adopted arrangement, therefore, places the entire reaction of the cables on the inner posts of the towers.

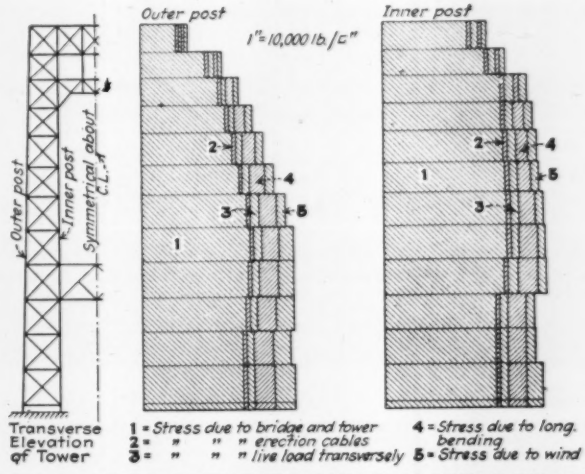

Outer post
Inner post
Symmetrical about C.L.
1"=10,000 lb/c"
Inner post
Transverse Elevation of Tower
1 = Stress due to bridge and tower
2 = " " " erection cables
3 = " " " live load transversely
4 = Stress due to long. bending
5 = Stress due to wind

FIG. 1—STRESS DISTRIBUTION IN STEEL TOWER POSTS OF HUDSON RIVER BRIDGE

Each tower frame is designed to act as a unit and to distribute the load elastically through all of its members to the pier pedestals.

Analysis of Steel Towers—As stated, the steel skeleton of each tower consists of four rigidly connected frames, each of which is assumed to take one-quarter of the external load when in a vertical position. Each frame in transverse elevation was treated as an individual unit. It forms a three-story frame with double bracing between the inner and the outer posts. To facilitate computation of the stresses, the frame was first split into two superimposed parts, each containing a single diagonal system. The stress determination was made by turning the frame into a statically determined system. The frame was cut in the middle vertically through the braces into two equal parts. Each part then was acting as a vertical cantilever subjected to the forces at the cuts. Each of the cut braces is subjected to an unknown horizontal thrust, a vertical shear and a moment, furnishing three equations of equilibrium. In addition, the forces in the two vertical members connecting the upper braces were introduced as unknowns. This means that eleven unknowns are required to com-

pute the stresses for any kind of external loading. For symmetrical loading, the shear in the three braces becomes zero and the forces connecting the two upper braces become equal. Therefore for this most important case the number of unknowns is reduced to seven. With this procedure the elastic theory furnishes for any given loading the number of equations necessary to compute the numerical values of the unknown forces. These are then treated as external loads acting on the statically determined system.

The application of the elastic theory requires at the outset the assumption of certain sectional areas in the various members of the towers. The computations have therefore to be repeated several times until agreement is reached between the assumptions made and the results obtained.

The elastic behavior of the frame is easily understood. The main external loads are the vertical cable reactions applied at the center of the inner posts. The reaction of the cables compresses the inner post and tends to shorten it. As the post shortens, the diagonals compel the outer post to follow and thus transfer stress to it. The stress so transmitted to the outer post is small at the top but gradually grows toward the bottom. It has been found to amount to but 4.5 per cent of the total cable reaction at the top and to increase to 46.5 per cent at the bottom (Fig. 2, *A*). On the other hand, the horizontal shear taken by the diagonals amounts to a total of 10,700,000 lb. in the top panel and decreases to 1,700,000 lb. in the lowest panel. The unit stress in the diagonals, including their participation (about 9,000 lb.) in the vertical reaction, is 24,000 lb. in the top panel and 14,000 lb. in the bottom.

In the final computations the method was further expanded and sixteen unknowns were introduced for unsymmetrical loading, which were reduced to ten unknowns for symmetrical loading. Furthermore, twelve unknown forces were introduced for the same number of diagonals.

Bending of the Tower Longitudinally—The tower in longitudinal elevation was treated by similar methods. It was taken into account that the posts, as well as the diagonals in both planes, will resist distortion. The tower will act as a unit, each post contributing in proportion to its distance from its neutral axis. For mathematical convenience the two inner frames were replaced by similar structures acting in the plane of the outer frames, by reducing their section according to their distances from the center of gravity of the acting masses.

Two cases of loading were treated—namely, bending of the tower top due to live load and temperature and bending due to wind forces on the tower and the bridge. For the first case the tower acts as a vertical cantilever and for the second as a vertical beam with the lower end fixed and the upper hinged. The horizontal force at the top of the tower, combined with the vertical cable reaction which produces the maximum displacement, acts in the plane of the inner posts. The stresses, therefore, will not be equally distributed in the tower bents. In the computations it was assumed for simplicity and safety that only the three main horizontal braces will force the outer posts to act together with the inner ones. Actually there are numerous horizontal braces between the posts in the bents, but these will contribute to the better distribution of the stresses.

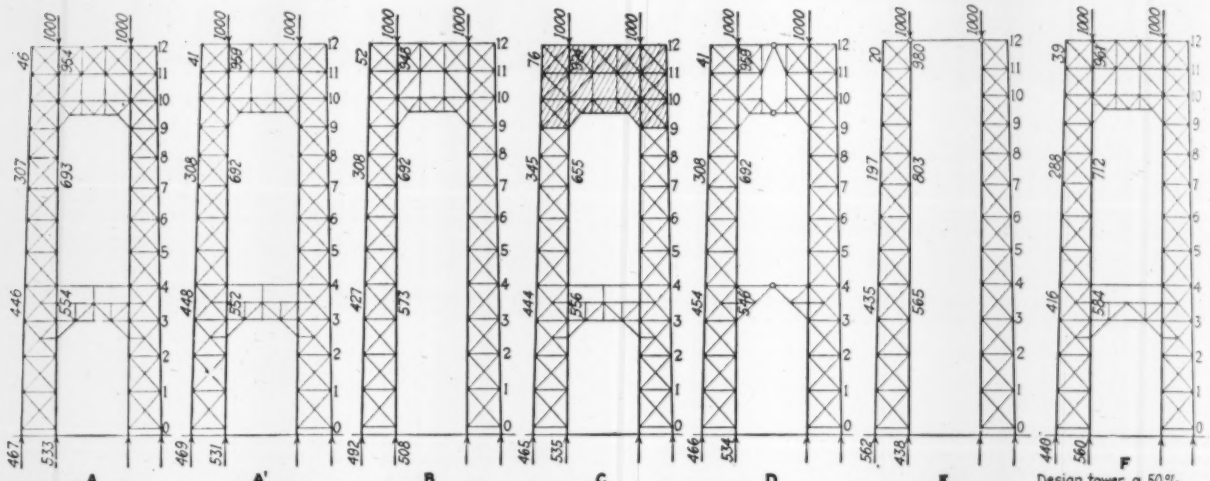

A
Design Tower
A'
Stress measurements by extensometer on celluloid model of design tower
B
Design tower, lower brace omitted
C
Design tower, area chords and diagonals in shaded portion increased three times
D
Design tower, braces assumed to be hinged as shown
E
Design tower, all braces omitted except top member hinged both ends
F
Design tower, a 50% modulus of elasticity assumed in diagonals between posts, equivalent to slip of 0.1 inch of each diagonal

FIG. 2—DESIGN STUDIES MADE BY VARYING ELASTIC SYSTEM OF ADOPTED TOWER BENT

The figures show the distribution of the two loads of 1,000 units between the inner and outer posts. In none of the studies except *E* was the variation from the adopted design stresses more than 4 per cent. In *E*, a practically impossible condition, the variation was 19 per cent. The close agreement between the analyzed and the measured stress distribution is shown by a comparison of *A* and *A'*

For symmetrical loading and bending, each horizontal brace will transmit a horizontal force from the inner to the outer post. These forces have accordingly been introduced in the elastic equations as unknowns. The difference in unit stress in the posts due to bending was found to be slight—1,560 lb. per sq.in. in the outer post as compared with 1,700 lb. per sq.in. in the inner post at the bottom of the structure. The distribution of stresses in the posts is shown in Fig. 1.

Studies of Variations in Tower Design—It was thought desirable to test the sensitiveness of the tower frame by varying the elastic conditions and the character and proportions of the braces connecting both bents. A measure was thus obtained of the steadiness of the behavior of the tower which affords interesting studies of the behavior of statically indeterminate structures of this type.

In Fig. 2 are shown a number of these studies, the figures indicating the distribution of two symmetrically

applied loads of 1,000 units in the various members of the frame. In *A*, the adopted design, it is clearly shown how the load travels down to the pier, being fed into the outer posts until at the pedestals it attains 46.7 per cent of the ideal 50 per cent. In *B*, by omitting the lower brace, the distribution of the load on the pier becomes nearly ideal. In *C*, although the top portal is three times as rigid as the one used, the variations in the stresses and reactions from those in the design tower are less than 4 per cent, proving the sufficient rigidity

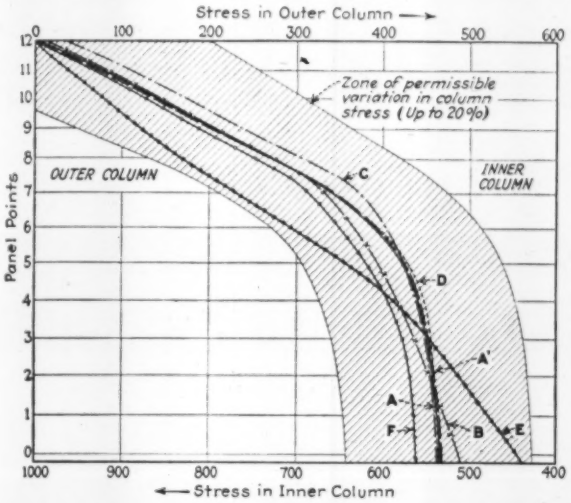


FIG. 3—TOWER STRESSES RESULTING FROM ALTERING, AS IN FIG. 2, THE ELASTIC SYSTEM OF THE ADOPTED BENT

Note that the zone of 20 per cent variation from the adopted design stress contains all stresses, resulting from even the extremely improbable conditions of the tower frame's elastic system.

of the top braces of the adopted design. In *D* the braces are hinged so that they cannot transmit moments, yet the variations in the stresses and reactions from those in the design tower are less than 1 per cent. In *E*, an extreme variation in the bracing made by replacing all the braces by a single strut hinged at both ends produced a maximum variation in the stresses of not more than 19 per cent from those of the design tower. Study *F* represents the tower as designed, except that it has been assumed that the modulus of elasticity of all diagonals between the posts is only one-half its normal value, or, what is the same, that their respective sectional areas are only one-half. This is also equivalent to a slip of 0.1 in. at one end of each diagonal. The resulting variations in the stresses and reactions are 3 per cent from those in the design tower. Studies of the effect of diagonals on the stress distribution are of importance, because here the connections are effected by rivets only and are not made on abutting ends.

To obtain a comprehensive picture of the results of these studies the resultant stresses were plotted in Fig. 3. A zone inclosing a variation of stress of 20 per cent is indicated on the drawing. It may be called the zone of permissible stress variation from computed theoretical stress values. Within this zone are found the extremely improbable and practically impossible variations that were the objects of these studies.

To arrive at a rough check of the stress distribution the tower may be considered as consisting of two tower bents for the lower nine panels and a comparatively rigid truss resting on top of these bents. The reactions applied on top of this truss would be distributed by it to the posts in the same manner as any truss transmits loads to its bearings. An analysis of the stresses shows that the truss as proportioned could safely transmit at least 40 per cent of the load to the outer posts, whereas the elastic computations require only about 30 per cent to be transmitted at that point. Following this assumption further and also assuming that all the diagonals in the bents in the lower nine panels had been omitted, the outer posts would, of course, sustain 40 per cent and the inner posts 60 per cent of the reaction at the top. Actually the outer posts are designed for a stress varying from 39 per cent at point 9 (Fig. 2) to 54 per cent at the bottom, and the inner posts for a stress from 75 per cent at point 9 to 54 per cent at the bottom.

The studies show that while the tower is statically indeterminate to a high degree, it is definite and steady in its behavior and little disturbed by variations from the assumptions on which the elastic computations are based.

Stress Measurements on Tower Model—As the design of the steel towers presented a novel feature in the planning of large bridges and as the analytical treatment of the towers involved the handling of many unknowns and required elaborate arithmetical computations, it was deemed desirable to obtain a verification of the action of the frames by testing a model of the structure. Since

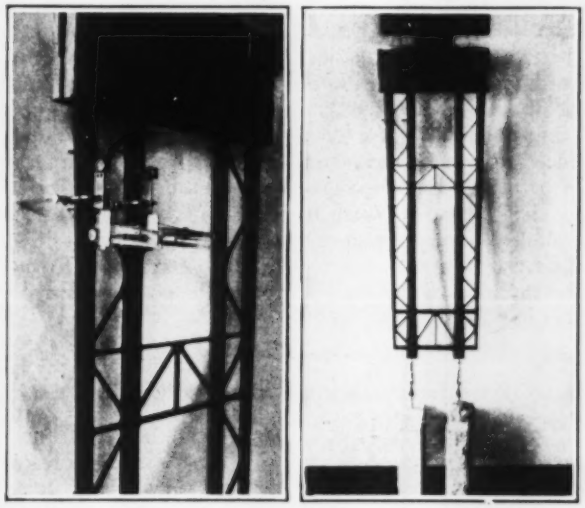


FIG. 4—CELLULOID TEST MODEL OF A TOWER BENT, HUDSON RIVER BRIDGE

Loads applied as tensile loads to eliminate possibility of flexure. Tensometers on inner and outer posts determined distribution of stresses as check on arithmetical analysis.

the main object of the test was to observe the distribution of stress between the posts, it was sufficient to consider one of the four frames only.

As material for the model, celluloid was selected because of its uniformity and ease of cutting. The largest sheets of celluloid obtainable were 50x20 in. and the scale of the model therefore was chosen accordingly. Each foot measured along the center line of the model corresponds to 140 ft. of the actual structure.

Areas were treated in a different manner. Within certain limits the width of these members affects the secondary stresses only, and if the measurements are taken along the center lines their influence vanishes. It was therefore advisable to keep the same thickness for all the members and vary the width only according to the area. In this way the model could be made of one piece. For further simplification the double bracing be-

tween the posts was replaced by a single set, and the two top braces were represented by one with a corresponding moment of inertia. These simplifications did not change the elastic behavior of the structure.

In order to keep the width of the smaller members within practical dimensions, it was found best to represent 1,000 sq.in. of the full-size structure by 1.6 in. of width in the model, the thickness being for all members the same—namely, 0.25 in. Therefore 1,000 sq.in. of steel corresponds to 0.4 sq.in. of the model, the ratio of reduction being 1 : 2,500.

In order to eliminate entirely any possibility of longitudinal flexure from applied compressive forces, the model was inverted and allowed to swing free, the load reactions being applied at the proper places as tensile forces (Fig. 4). The model was subjected to two equal loads of 62.5 lb., producing a maximum unit stress in the frame of 108 lb. per sq.in., a stress well within the elastic limit of the celluloid.

In making the tests, two Huggenberger tensometers with a magnification of 1,000 and a gage length of 1 decimeter (3.937 in.) were placed on the same level (Fig. 4), one on the center line of the inner post and the other on the center line of the outer post of the same side of the model. The first tensometer readings were taken with no load. The model was then subjected to the two loads and the second set of readings was taken. The load was again removed and the third set of readings was recorded. These corresponded closely to the first readings. The elongation of the first test is the average of the above two differences—that is, the difference between the first and the second reading and the difference between the second and the third reading. In order to get a fair average, the test was repeated four times.

The elongations were magnified 1,000 times and the distances observed attained an average of about 1 in., a difference large enough to derive close results. In fact the variation of the analytical from the observed stresses was less than 1 per cent.

New Jersey Dams Controlled by State

Control over all dams in New Jersey having a tributary drainage area of more than 1 square mile has rested with the Division of Waters of the New Jersey Board of Conservation and Development since 1916. Recent action of the legislature has reduced the exempt area to ½ square mile, so that all dams impounding any considerable amount of water are now under state control.

Plans and specifications for proposed dams must be approved before construction starts. The site is closely inspected, especially as regards foundation conditions, and frequent inspections are made during construction to insure good engineering practice. A final examination is made after the completion of the dam before permission is granted to start water storage. As a result of these precautions, not one of the 140 dams erected under state supervision has failed for any cause.

Existing dams are also examined to determine their stability and safety, and a record is kept of the salient features of each one. When a complaint is filed, the board makes an inspection and furnishes the complainant with a report of its findings. Should the dam be found unsafe, the owner is notified and required to make adequate repairs or unwater the pond. This activity has resulted in the repair of five dams and the unwatering of one.

Heavy Balcony Construction of Concrete

Replaces Steel Design—90-Ft. Reinforcing Bars in Heavy Girder—Column Connections Designed to Transmit No Moment

By R. C. Reese
Consulting Engineer for Building Products Company, Toledo, Ohio

THE BALCONY of Schine's Theater at Lima, Ohio, is of interest because it incorporates an 82-ft. concrete girder and a number of unusual details and because its construction required certain special methods of concreting. Originally designed in structural steel with a main box girder, cantilever trusses, concrete slabs and plate-and-angle risers, the balcony was later redesigned in reinforced concrete. The main reason for the change was that the concrete design permitted quicker construction. Several other important points were demonstrated during the construction of the balcony. Reinforced-concrete theater balconies of 82-ft. span are feasible and economical, are not much more bulky than steel girders and have a greater effective depth if the steps are poured monolithic with the girder; they make a stiffer building, and because of their high ratio of dead load to live load reduce the effect of overloading, impact or panic.

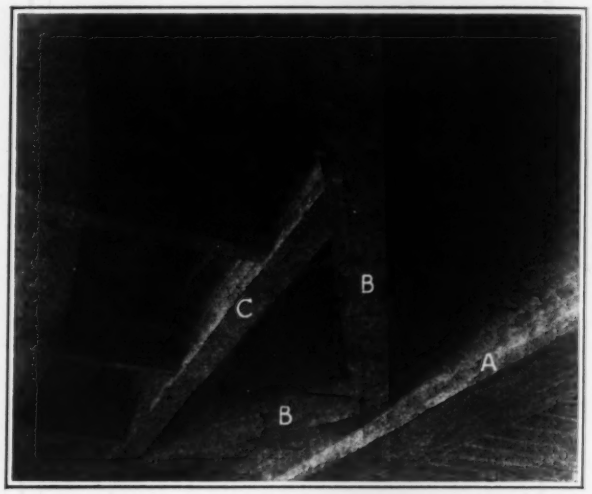


FIG. 1—UNDERSIDE OF REINFORCED-CONCRETE BALCONY FRAMING
Note tapered tees on beams.

Design—The theater is 202x82 ft. in ground plan, with a single balcony 43x82 ft. The general arrangement of the balcony framing is shown in Fig. 2. The main girder, *A*, spans the full width of the auditorium and supports most of the balcony and a portion of the mezzanine foyer floor. Diagonal fulcrum girders, *B*, and the rectangular fulcrum girder, *C*, cut down the overhang of the cantilever girders and keep them of reasonable proportions. The design was made for a live load of 80 lb. per sq.ft. of horizontal projection. However, the live load was of secondary importance, since it required about 5 lb. dead weight of concrete to support each pound of live load.

It was originally planned to treat the main girder and its supporting columns as a rigid frame, but this

idea was abandoned as impracticable. The adopted design provided a column-to-girder connection that would not transmit any moment and would approach as closely as possible a pin connection on the column center. When the columns were poured, three vertical dowel rods were set on the center line of the column. Over these rods were placed two ½-in. steel plates with a ¼-in. lead plate between; all plates covered the column cross-section to within 1 in. of the edge. The lower steel plate was carefully grouted level, and then the three plates were protected by a dike of clay until the girder above was poured. There may be some question as to how much moment will pass through a detail of this sort, but the slender columns are carrying their load without buckling and the detail has served its purpose in a satisfactory manner.

Each of the large girders was isolated and detailed to a large scale. This seems to be a practice that is rapidly passing in this country, but on this particular job the network of steel where the girders intersected made this method desirable. Beam tees were tapered from midspan toward the ends to lighten the dead load and reduce the quantity of concrete required for these members.

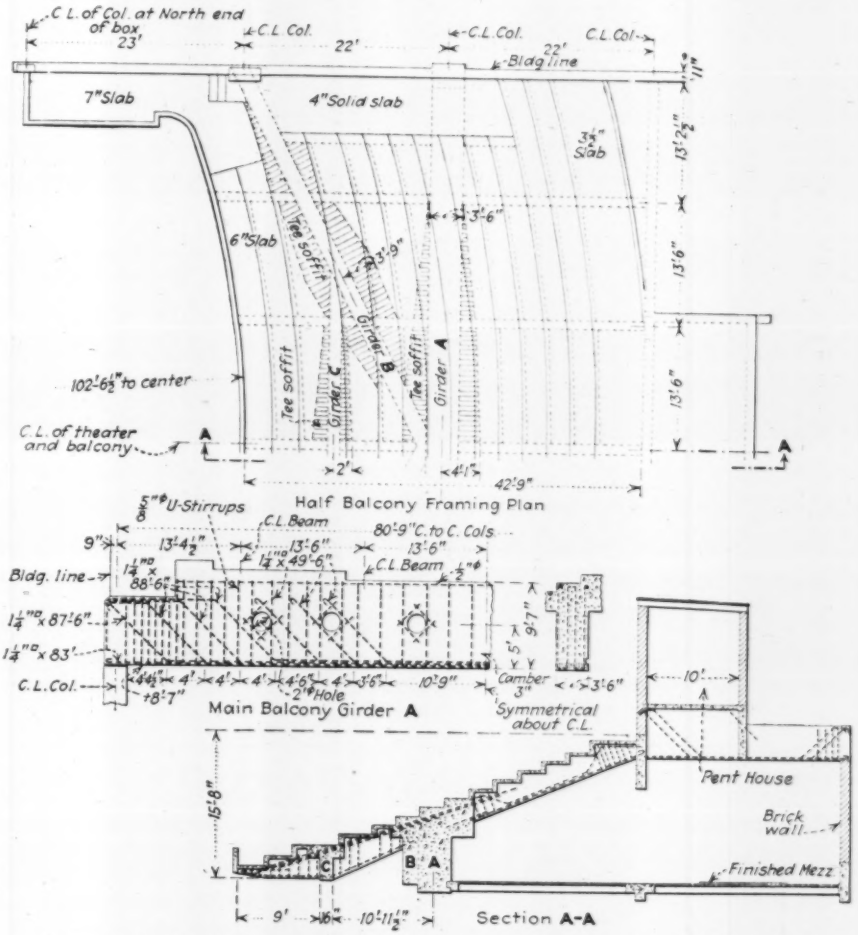


FIG. 2—DETAILS OF REINFORCED-CONCRETE BALCONY WITH 82-FT. SPAN

Reinforcement of the steps was of wire cloth, as is usual practice. It is particularly desirable when the final finish is made monolithic with the pouring and has advantages over loose rods in reducing temperature cracks and crazing.

At the request of the contractor it was decided not to splice the 90-ft. reinforcing bars of the main girder. This proved to be a wise procedure, because the splicing of fifty-one 1¼-in. square bars would have used valuable space in the somewhat crowded lower portion of the girder. These 90-ft. bars were rolled from car axles and cut and bent at the mill to details shown in Fig. 2. They were hauled about 56 miles by truck and trailer from the mill to the building site. Some difficulty was experienced in handling them through the streets of Lima, but in general the experiment was successful.

Formwork and Concreting—Special care was taken in designing the formwork because of the heavy loads, especially in the main girder. This girder was cambered 3 in. at midspan to allow for the settlement of the mudsills and for the compression of the supporting woodwork. The actual deflection of the girder when the forms were stripped was scarcely measurable, but the camber serves the good purpose of overcoming the optical illusion of sagging that results from a level soffit.

Three pours of concrete were used in the balcony. The first pour included the front of the balcony from the connected boxes and front rail back to the far side of the main girder. The second pour consisted of the mezzanine foyer floor, which rested in a continuous slot previously formed at the lower part of the main girder. The third pour included the rear portion of the balcony and the picture booth floor. Besides the slot left in the main girder to carry the mezzanine floor, pockets were formed in this girder to carry the lower ends of the upper balcony beams. The beam reinforcement extended across this intersection at both the top and bottom of these balcony beams.

Because of the crowded condition of the reinforcing steel at the bottom of the girders, the first 6 or 7 in. at the bottom was poured with a special mix of concrete, using as coarse aggregate rock of from ¼ to ⅜ in. ring measure. On top of this layer and thoroughly spaded into it was placed the regular concrete, using stone of 1-in. to 1½-in. size. This change in the type of concrete, together with the use of long reinforcing bars previously noted, greatly reduced the posibility of voids being left in the lower parts of the girders.

The architects were Peter M. Hulsken and Lyman T. Strong, and the contractors were Green & Sawyer, all of Lima, Ohio. The redesign was made by the writer for the Building Products Company, of Toledo, which furnished the reinforcing material. After the design was made it was checked by W. H. Adams, consulting engineer, of Detroit.

Provisions for Flood Control Under New Law

Commission to Recommend Action to President After Considering Plans—Work to Be Under Direction of M.R.C.

A DIGEST of the bill, recently approved by President Coolidge, which provides for governmental action in protecting the Mississippi Valley from a repetition of the disastrous floods of 1927, is given below. It is known as the Jones-Reid bill (S. 3740). The text is that of the law itself, simplified by the omission of the confusing words, phrases and legal verbiage.

The project for the flood control of the Mississippi River from the Head of Passes to Cape Girardeau, Mo., in accordance with the plan in the report by the Chief of Engineers [General Jadwin] dated Dec. 1, 1927, is adopted. A board to consist of the Chief of Engineers, the president of the Mississippi River Commission and a civil engineer chosen from civilian life by the President is created; such board to consider the engineering differences between the adopted project and the plans recommended by the Mississippi River Commission in its special report dated Nov. 28, 1927, and after such study and such further surveys as may be necessary, to recommend to the President such action as it may deem necessary. The decision of the President upon all recommendations submitted by such board shall be followed.

Surveys—Such surveys shall be made between Baton Rouge, La., and Cape Girardeau, Mo., as the board may deem necessary to enable it to ascertain and determine the best method of securing flood relief in addition to levees, before any flood-control works other than levees and revetments are undertaken on that portion of the river; provided that all diversion works and outlets constructed under the provisions of this act shall be built in a manner and of a character which will fully and amply protect the adjacent lands; provided further that, pending completion of any floodway, spillway or diversion channel, the areas within the same shall be given the same degree of protection as afforded by levees on the west side of the river contiguous to the levee at the head of said floodway, but nothing herein shall prevent, postpone, delay or in anywise interfere with the execution of that part of the project on the east side of the river, including raising, strengthening and enlarging the levees on the east side of the river.

Funds—The sum of $325,000,000 is authorized to be appropriated for this purpose.

Local Contribution—It is hereby declared to be the sense of Congress that the principle of local contribution toward the cost of flood-control work, which has been incorporated in all previous national legislation on the subject, is sound, as recognizing the special interest of the local population in its own protection and as a means of preventing inordinate requests for unjustified items of work having no material national interest. As a full compliance with this principle, in view of the great expenditure, estimated at approximately $292,000,000, heretofore made by the local interests in the alluvial valley of the Mississippi River for protection against the floods of that river; in view of the extent of national concern in the control of these floods in the interests of national prosperity, the flow of interstate commerce and the movement of the United States mails; and in view of the gigantic scale of the project, involving flood waters of a volume and flowing from a drainage area largely outside the states most affected and far exceeding those of any other river in the United States, no local contribution to the project herein adopted is required.

Except where authorized by the Secretary of War upon the recommendation of the Chief of Engineers, no money shall be expended until the states or levee districts have given assurance that they will (*a*) maintain all flood-control works after their completion, except controlling and regulating spillway structures; (*b*) accept land turned over to them; (*c*) provide rights-of-way for levee foundations and levees on the main stem of the Mississippi between Cape Girardeau, Mo., and the Head of Passes.

Flood Liability Not Assumed—No liability of any kind shall attach to or rest upon the United States for any damage from or by floods or flood waters at any place; provided, however, that if in carrying out the purposes of this act it shall be found that upon any stretch of the banks of the Mississippi River it is impracticable to construct levees, either because such construction is not economically justified or because such construction would unreasonably restrict the flood channel, and the lands in such stretch of the river are subjected to greater overflow and damage which are not now overflowed or damaged by reason of the construction of levees on the opposite banks of the river, it shall be the duty of the Secretary of War and the Chief of Engineers to institute proceedings on behalf of the United States government to acquire either the absolute ownership of the lands so subjected to overflow and damage or floodage rights over such lands.

U. S. to Acquire Lands—The United States shall provide flowage rights for additional destructive flood waters that will pass by reason of diversions from the main channel of the Mississippi River; provided that in all cases where the execution of the flood-control plan herein adopted results in benefits to property, such benefits shall be taken into consideration by way of reducing the amount of compensation to be paid.

The Secretary of War may cause proceedings to be instituted for the acquirement by condemnation of any lands, easements or rights-of-way which, in the opinion of the Secretary of War and the Chief of Engineers, are needed in carrying out this project; provided that any land acquired under the provisions of this section shall be turned over without cost to the ownership of states or local interests.

Subject to the approval of the heads of the executive departments concerned, the Secretary of War may engage the services of the Coast and Geodetic Survey, the Geological Survey or other mapping agencies of the government.

Pending Work Included—Funds appropriated under authority of section 1 of this act may be expended for the prosecution of such works for the control of the floods of the Mississippi River as have heretofore been authorized and are not included in the present project, including levee work on the Mississippi River between Rock Island, Ill., and Cape Girardeau, Mo., and on the outlets and tributaries of the Mississippi River between Rock Island and Head of Passes, in so far as such out-

lets or tributaries are affected by the backwaters of the Mississippi; provided that for such work on the Mississippi River between Rock Island, Ill., and Cape Girardeau, Mo., and on such tributaries the states or levee districts shall provide rights-of-way without cost to the United States, contribute 33⅓ per cent of the costs of the works and maintain them after completion; and provided further that not more than $10,000,000 of the sums authorized in section 1 of this act shall be expended under the provisions of this section.

In an emergency, funds appropriated under authority of section 1 of this act may be expended for the maintenance of any levee when it is demonstrated to the satisfaction of the Secretary of War that the levee cannot be adequately maintained by the state or levee district.

The sum of $5,000,000 is authorized to be appropriated as an emergency fund to be allotted by the Secretary of War on the recommendation of the Chief of Engineers, in rescue work or in the repair or maintenance of any flood-control work on any tributaries of the Mississippi River, threatened or destroyed by flood including the flood of 1927.

M. R. C. to Direct Work—The project herein authorized shall be prosecuted by the Mississippi River Commission under the direction of the Secretary of War and supervision of the Chief of Engineers and subject to the provisions of this act. It shall perform such functions and through such agencies as they shall designate after consultation and discussion with the president of the commission. For all other purposes the existing laws governing the constitution and activities of the commission shall remain unchanged.

The president of the commission shall be the executive officer thereof and shall have the title brigadier general, Corps of Engineers; provided that the present incumbent of the office may be appointed a brigadier general of the army, retired, and shall be eligible for the position of president of the commission if recalled to active service by the President under the provisions of existing law.

The salary of the president of the Mississippi River Commission shall hereafter be $10,000 per annum, and the salary of the other members of the commission shall hereafter be $7,500 per annum.

Other Plans to Be Investigated—It is the sense of Congress that the surveys of the Mississippi River and its tributaries, authorized pursuant to the act of Jan. 21, 1927, and House document numbered 308, Sixty-ninth Congress, first session, be prosecuted as speedily as practicable, and the Secretary of War, through the Corps of Engineers, United States Army, is directed to prepare and submit to Congress at the earliest practicable date projects for flood control on all tributary streams of Mississippi River system subject to destructive floods, which projects shall include: The Red River and tributaries, the Yazoo River and tributaries, the White River and tributaries, the Saint Francis River and tributaries, the Arkansas River and tributaries, the Ohio River and tributaries, the Missouri River and tributaries and the Illinois River and tributaries; and the reports thereon, in addition to the surveys provided by said House document 308, Sixty-ninth Congress, first session, shall include the effect on the subject of further flood control of the lower Mississippi River to be attained through the control of the flood waters in the drainage basins of the tributaries by the establishment of a reservoir system; the benefits that will accrue to navigation and agriculture from the prevention of erosion and siltage entering the stream; a determination of the capacity of the soils of the district to receive and hold waters from such reservoirs; the prospective income from the disposal of reservoired waters; the extent to which reservoired waters may be made available for public and private uses; and inquiry as to return flow of waters placed in the soils from reservoirs, and as to their stabilizing effect on stream flow as a means of preventing erosion, siltage and improving navigation.

The flood surveys herein provided for shall be made simultaneously with the flood-control work on the Mississippi River provided for in this act and the President shall proceed to ascertain, through the Secretary of Agriculture and such other agencies as he may deem proper, the extent to and manner in which the floods in the Mississippi Valley may be controlled by proper forestry practice.

Overflow Damages—The Secretary of War shall cause the Mississippi River Commission to make an examination and survey of the Mississippi River below Cape Girardeau, Mo. (*a*) at places where levees have heretofore been constructed on one side of the river and the lands on the opposite side have been thereby subjected to greater overflow, and where, without unreasonably restricting the flood channel, levees can be constructed to reduce the extent of this overflow, and where the construction of such levees is economically justified, and report thereon to the Congress as soon as practicable with such recommendations as the commission may deem advisable; (*b*) with a view to determining the estimated effects, if any, upon lands lying between the river and adjacent hills by reason of overflow of such lands caused by the construction of levees at other points along the Mississippi River, and determining the equities of the owners of such lands and the value of the same, and the commission shall report thereon to the Congress as soon as practicable with such recommendations as it may deem advisable; provided that inasmuch as the Mississippi River Commission made a report on Oct. 26, 1912, recommending a levee to be built from Tiptonville, Tenn., to the Obion River in Tennessee, the Mississippi River Commission is authorized to make a resurvey of the proposed levee and a relocation of it if necessary, and if such levee is found feasible and is approved by the board created in section 1 of this act and by the President, it shall be built out of appropriations hereafter to be made.

Sacramento River—The project for the control of floods in the Sacramento River, approved March 1, 1917, is modified in accordance with the report of the California Débris Commission; provided that the total amount contributed by the federal government, including the amounts previously contributed, shall not exceed $17,600,000.

Highway Grade-Crossing Accidents Decrease in 1927

Reductions in 1927 compared with the year before not only in the number of highway grade-crossing accidents but also fatalities resulting therefrom have been reported by the railroads to the Interstate Commerce Commission. Persons killed in 1927 as a result of such accidents totaled 2,371, a reduction of 120 as compared with 1926, whereas 6,613 persons were injured, a reduction of 378 compared with the preceding year.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Sturtevant Named As Third Member of Flood-Control Board

President Coolidge Nominates Civilian Engineer Familiar With Mississippi Work

AS THE third member of the Mississippi Flood-Control Planning Board, the President has nominated C. W. Sturtevant, an engineer with a wide experience in river control, in dredging and in the building of locks, dams and other channel structures, and one who began his professional career upon the Mississippi River and subsequently spent many years there in charge of dredging and other river-control work. The appointment of Colonel Sturtevant is subject to confirmation by the Senate. The two other members of the board are to be the Chief of Engineers, Major General Edgar Jadwin, and the president of the Mississippi River Commission, presumably Col. Charles L. Potter, who now holds that position, although past the retirement age, as the flood-control bill (see p. 824 of this issue) makes provision for continuing him in active service for that purpose if the President so desires.

Carleton W. Sturtevant is a native of Ohio and a graduate of Missouri State University, class of 1884. Immediately after graduation he worked for a year as a transitman on the Mississippi River surveys and then for three years was on railroad surveys and construction and also on surveys along the Red River, returning to the Mississippi River work in October, 1888, to become an assistant engineer with the Mississippi River Commission. This position he held until 1897, first being engaged in surveys and bank-protection work, including the construction of dikes and willow mattresses, and then in charge of experimental dredging work. In 1897 he was made superintendent of dredging in the whole delta region from Cairo to the Passes.

At the outbreak of the Spanish-American War, Mr. Sturtevant was appointed a captain in the Third Regiment, U. S. Volunteer Engineers, which position he held until March, 1899, when he was promoted to rank of major of the third battalion of the same regiment. At this time he was in charge of wharf and road construction at Matanzas, Cuba.

After the war Major Sturtevant returned to the Mississippi River Commission to take up again his work as superintendent of dredging, a position which he held until January, 1902,

(Continued on page 828)

Greenville Dam Holds While Reservoir Slowly Drains

Conditions at the Table Rock Cove dam, near Greenville, S. C., which suffered a partial drain-pipe washout on May 4, have continued favorable, according to word from Col. J. L. Ludlow, consulting engineer to the city. Lowering of the pool by Sunday, May 13, reached 35 ft. below spillway level, and since then the lowering has been gradual but steady. Sloughing of the sides of the washout gorge has continued, particularly at the south side, but not seriously. A telephone line has been carried to the dam. Sandbags have been made ready on top of the dam for any emergency use. A sandbag revetment has been placed along the rear and sides of the washout gorge to limit erosion as much as possible.

A large portion of broken-out bell end of pipe became visible in the gorge about 20 ft. from the break. The 42-in. pipe is of Class D weight and had been tested to 300 lb. hydrostatic pressure before being shipped from the foundry.

Settlement of Controversy Over Buffalo Filter Defects

Settlement for $150,000 of the judgment for $191,000 against the city of Buffalo, N. Y., obtained by the Thompson-Starrett Company for work done at the water-filtration plant has been authorized by the city council in the form of a vote overriding the mayor's veto of a resolution to that effect. The plant has been in operation since 1926. Acting on a report made by a committee of the Buffalo Section of the American Society of Engineers, after an inspection of the plant on Sept. 15, 1927, the section adopted resolutions declaring that although defects in the plant were found they were not serious, provided they are properly repaired.

To Hold Summer Schools for Engineering Teachers

Plans have been completed for two schools for teachers of engineering to be held under the auspices of the Society for the Promotion of Engineering Education at the University of Pittsburgh and at Massachusetts Institute of Technology. The electrical engineering session, in Pittsburgh, will open on July 5 and close on July 25. A number of meetings will be held at the Westinghouse Electric & Manufacturing Company's plant. The physics section, at Cambridge, will open on July 9 and close on July 28.

Economic Progress Is Reviewed at Industrial Board Annual Meeting

Sherman Law Operating Satisfactorily —Analysis of Unemployment— Chemical Achievements

A REVIEW of today's most pressing business problems and of the contributions of science and engineering to economic progress was the outstanding feature of the twelfth annual meeting of the National Industrial Conference Board, held in New York on May 17. Particularly notable were addresses by Gilbert H. Montague, declaring that the Sherman law is being satisfactorily modified by interpretation, and by Charles H. Herty on the great contribution that chemistry has made to economic progress. Prof. Michael I. Pupin praised the college professor as the father of the electrical industry and the creator of that scientific idealism which he pictured as a proper policy for industry.

Mr. Montague, a New York attorney who is an authority on the Sherman law, declared that legislation is being constantly modified by the increasing liberality of court decisions on consolidations and combinations, by action of the Federal Trade Commission and by a liberal attitude on the part of the Department of Justice. He declared emphatically that it is not true that American business cannot thrive under the present anti-trust laws. He believes that the modifications are such and the tendency so liberal that we should not attempt to tamper with the Sherman law by amendment and thus set up additional bureaucratic machinery and create unsettlement, until the meaning of the new amendments can be determined through experience.

Unemployment and Mechanization

Discussing unemployment, Magnus W. Alexander, president of the board, proved the unreliability of the figures of 4,000,000 and more unemployed. He made a satisfactory defense, also, of the thesis that the mechanization of industry should not be curtailed because of any temporary effect it might have on the unemployment problem.

Virgil Jordan, chief economist of the board, made the point that those who expect our private foreign loans to be repaid when due are sure to be disillusioned. He believes that these loans will be funded and refunded indefinitely, just as are the bonds of large corporations in the United States. This he held to be the normal expectation. Nevertheless, our large loans abroad set

up a new financial relationship between the rest of the world and the United States and create intricate problems, which require deep study by industrialists.

William J. Schultz, financial economist of the board, contended that one of the large problems before business today is to assist in bringing the government's expenditures, and consequently taxation, under proper control. He proposed half a dozen expedients having this purpose in view, but emphasized particularly the desirability of control by the state or some central supervising body of the expenditures of counties, cities and other local governmental units. He referred with approbation to the practice of certain states in underwriting the bonds of local government bodies, thus enabling borrowing to be effected at lower rates.

CONTRIBUTIONS TO ECONOMIC PROGRESS

Dr. Herty, adviser to the Chemical Foundation, New York, sketched chemistry's contribution to economic progress. It has enormously increased our gasoline supply through the cracking process; has given us a new lacquer industry, which has contributed notably to the reduction in the cost of automobile manufacture; has established the corn sugar industry, which has a product of 500,000,000 lb. annually, and given us rayon, of which 75,000,000 lb. was produced in the United States in 1927. Further progress will lead us into a cellulose and starch era, which carries tremendous possibilities for additions to our national wealth. The present agricultural nuisance, cornstalks, give promise of adding $1,000,000,000 in value of useful products through the use of their cellulose content. The cotton fields of the South today produce enough cottonseed meal to meet, when properly refined, the protein requirements of 53,000,000 people, or 46 per cent of our present population. The estimated cost of protein from this source is 5c. per pound, against 25c. per pound for the protein in corn meal, 39c. in wheat flour, $2.65 in milk and $3.70 in mutton chops. He suggested that the organic acid obtainable from resin and the cellulose in peanut shells would also add enormously to the wealth of the United States when research has turned these substances into usable products.

Kenneth H. Condit, editor of *American Machinist*, New York, showed that modern metal-working machinery frequently pays for itself in a year and less.

Rail Merger Plans Mostly Meet With Disapproval

The Interstate Commerce Commission has approved the application of the Chesapeake & Ohio Railroad for permission to absorb the Pere Marquette, but has refused to grant its approval of the proposed acquisition of the Erie, in furtherance of the Van Sweringen merger plan. The commission states that the applicant has not demonstrated a necessity for control of the Erie, and, as a further objection, that the merger with the Erie would constitute "practically an allocation of an important New York-Chicago trunk line in advance of the adoption of any general plan for the formation of competitive systems in the Eastern territory."

The commission refused the application of a number of officers and directors of the Baltimore & Ohio, the New York Central and the New York, Chicago & St. Louis (Nickel Plate) for authority to serve as directors of the Wheeling & Lake Erie Railway, in which these roads recently acquired a stock interest. The application was characterized as premature, being in advance of any application for authority to exercise control over the road in question.

The application of the Seaboard Air Line for authority to acquire control of the South Georgia Railway, which extends 81 miles from Adel, Ga., to Hampton Springs, Fla., was also denied.

Leak Endangers Earth Dam in Utah

On May 21 a leak through the base of the Pleasant Valley irrigation dam, near Scofield, Utah, in the Price River basin, aroused fears of impending failure of the dam and caused alarm throughout the Price River Valley. At the time of going to press no further developments were reported, but attempts were being made to protect the dam by sandbagging.

The Pleasant Valley dam is an earth-and-rock-fill embankment 63 ft. high above stream bed and 78 ft. high above bedrock, across the valley of Fish Creek, a tributary of Price River, and forms a reservoir of 61,000 acre-ft., practically equal to the annual runoff of the 167 square miles of drainage area. It was completed last year by the Price River Water Conservation District, and replaces (at a new site) the Mammoth dam, which failed in 1917 because of incompetent design and construction.

In its downstream portion the embankment is a rock fill, with downstream slope 1 on 1½ and hand-laid upstream base sloping 1 on ¾; the upstream portion of the dam is rolled earth fill laid against the steep base of the rock fill and having an upstream slope of 1 on 3, riprapped 12 in. The earth is an impervious material consisting of disintegrated sandstone and shale.

A major fault traverses the site, but the engineers considered the soil overburden to be deep enough to seal the reservoir, and it is reported that storage last year verified this belief.

Discharge provisions include a spillway through the rock abutment, with 4,800 sec.-ft. capacity, and a 6-ft. outlet tunnel through the opposite abutment, of 1,000-sec.-ft. capacity.

During construction, springs developed in the floor of the outlet tunnel and in the core trench near the south abutment, both of which were drained, the latter into a drain in the creek bed.

The rock fill rests on the natural earth surface, while its upstream hand-laid facing was carried down to rock.

Two years ago, during construction, 13,000 acre-ft. were stored in the reservoir, while last year 47,000 acre-ft. were stored (to 7 ft. below pool level). Last September the middle of the dam was found to have settled 18 in., but the ends showed no settlement. The rock-fill part settled 6 in. more than the earth-fill part. No longitudinal cracks were found, but a shallow transverse crack developed near the spillway end.

McGonagle & Ulrich, of Salt Lake City, were engineers for the dam, and the Reynolds-Ely Construction Company, of Springville, Utah, built it.

Chicago Plans Air-Right Roads

A project for elevated highways or boulevards over existing railways by utilizing air rights, has been submitted to the city council of Chicago by the council committee on traffic regulation. This project, suggested by a sub-committee on two-level streets, is based on the idea of separating through or long-distance automobile, motor-coach and motor-truck traffic from ordinary street traffic, in the same way that railway traffic in the city has been removed from the street level by grade separation. A similar project at Boston is cited in the report; also the location of Park Ave., New York, above railway tracks. Eight routes for such elevated radial highways are shown, estimated to cost in all about $250,000,000. To raise the necessary funds it is suggested that an "aerial highway district" might be created, with bond-issuing powers up to $300,000.

Amendment to Federal-Aid Act Vetoed by President

A bill which would appropriate $3,500,000 each year for the next three years for the purpose of constructing main roads at federal expense through unappropriated or unreserved public lands, or non-taxable Indian lands, has been vetoed by the President on the ground that this would constitute a radical departure from the established policy of federal aid to the states. The bill, framed as an amendment to the federal-aid act of 1916, had passed both houses of Congress.

Plaintiff Wins Zoning Suit at Cambridge, Mass.

A specific application of the zoning ordinance of Cambridge, Mass., has been declared invalid by the U. S. Supreme Court, by an appeal from the Massachusetts Supreme Court (Nectow vs. City of Cambridge, No. 559, Supreme Court of the United States; reported in full in *U. S. Daily*, May 16, 1928). The suit applied to 29,000 of 140,000 sq.ft. of land owned by the plaintiff, the smaller portion being in a residence district and the remainder in an unrestricted district. Close by were various industrial plants. A projected street would narrow to 65 ft. the strip

of land in question. The plaintiff was about to sell his entire holding for manufacturing purposes when the prospective purchaser declined because of the restriction on part of the land. A master reported to the state court that the land is of little value for residential purposes, but recommended that the ordinance be sustained, and his advice was followed by the state court. The U. S. Supreme Court, while upholding the general validity of the ordinance, in accordance with the Euclid (Ohio) decision, ruled that, as applied to the land of the plaintiff, the effect of the ordinance was confiscatory and reversed the decision of the state court.

Sturtevant on Flood Board

(*Continued from p. 826*)

when he left the commission to become general superintendent for the Atlantic Gulf & Pacific Company on dredging work on the diversion canal at Vicksburg, Miss. Subsequently, he had charge of dredging for the same company in Mobile Bay and on the Mobile River, also on the Pascagoula River, Miss., and in Tampa Bay, Fla. From the Tampa work he went to Lynn, Mass., to make maps and designs for wharves and land reclamation in the harbor at that point. At the completion of this work he took charge for the same company of a contract on the Barge Canal at Port Ann, N. Y., and from that work went to Panama to supervise the construction of the dredges built for the canal commission. These dredges were built with material sent out from the States, using native labor.

In January, 1909, Mr. Sturtevant returned to the New York State Barge Canal work as general superintendent for James Stewart & Company, on the construction of 83 miles of Barge Canal from Montezuma Swamp to Oneida Lake, and from Three Rivers to Fulton, N. Y., with locks, dams and bridge piers. Subsequently he had charge of dredging in Toronto harbor for the same company. In May, 1913, he again returned to the Barge Canal work as general superintendent for the New York State Dredging Corporation in charge of seven barge canal contracts and a 5,000,000-cu.yd. hydraulic fill for the New York Central Railroad Company at Utica, N. Y., also terminal wharves at Port Henry, N. Y.

At the outbreak of the World War, Mr. Sturtevant, then a major in the Reserve Corps, was working on the deeper Hudson project between Albany and Troy on submarine rock excavation. He was called into active service on May 8 and ordered to report to Fort Riley, Kansas. Within a short time Major Sturtevant was assigned to the Fifteenth Engineers (Railway) then being organized at Pittsburgh, and sailed for France early in July, 1917, as lieutenant colonel of that regiment under Col. Edgar Jadwin as commanding officer. Shortly after arriving in France Colonel Jadwin was promoted, and in two months Lieutenant Colonel Sturtevant was put in command of the regiment. The work of the Fifteenth Engineers included the direction of the construction of the great intermediate storage depot at Gievres, and the regulating station at Liffol le Grand, and after the armistice, reconstruction of part of the railway line from Verdun to Conflans, and also a line into Sedan. Lieutenant Colonel Sturtevant was promoted to the rank of colonel shortly before the armistice. He was discharged from the service on May 7, 1919, and immediately returned to James Stewart & Company to make examinations and report on harbor works in the United States and Cuba, and also on the Magdelena River in Colombia, South America, at Barranca-Bermeja, also on bank-protection work on the Dique Canal adjoining the same river.

Returning to the United States in January, 1921, Mr. Sturtevant was, for a year, with Woods Brothers Construction Company on bank-protection work on the Missouri River from Sioux City to Kansas City. For the next three years he was again with the James Stewart company as a superintending engineer until July 1, 1925, when, at the request of the Chief of Engineers, he was released from that work to take charge of the field office making surveys and borings and preliminary plans on the St. Lawrence Waterway for the Joint Board of Engineers. After this work was completed he went to Mexico in March, 1927, for the J. G. White Engineering Corporation, to become superintending engineer on the reinforced-concrete dam and irrigation canal of the Mexican government Rio Mante irrigation project at Xicotencatl, Mexico. Colonel Sturtevant had just returned from this work when his selection to become a member of the Mississippi Planning Board was announced.

New York City Engineers Protest Delay in Pay Increase

Although the technical employees of the city of New York were granted a $600,000 increase in salary last October, no distribution of the increase has as yet been made. One protest by the Union of Technical Men against the Board of Estimate's manner of handling the matter brought no results. The union has, therefore, undertaken another campaign to bring about the immediate distribution of the increase. A letter will be sent to the Board of Estimate demanding a definite reply as to when and how the increase will be distributed. If then no action is taken by the board, the union will make a final effort to have Mayor Walker receive its delegation. Failing this, it is reported, the technical men will hold a mass demonstration in protest at the City Hall. Demands of the Union of Technical Men regarding the distribution of pay increases are: (1) that every man be given a 25 per cent increase, all sharing alike, and (2) that this increase be retroactive to Jan. 1, 1928.

Kansas City Bond Vote Fails

Lacking the necessary two-thirds vote, the greater part of propositions contained in Kansas City's $30,000,000 bond issue failed to carry. The proposition for the extension and additions to the water-works system of the city involving $3,000,000 lacked 428 votes. Other projects that lost with a 1,000 to 4,000 majority against them were an airport, a new city hall, new traffic ways, the Blue River improvement and a municipal auditorium. Of the county bonds that were included in the election, those for a new county hospital involving $500,000 and those for a county highway system involving $6,500,000 were approved. Court houses for Kansas City and Independence failed to secure approval.

H. F. McElroy, city manager, and Mayor Beach both stated that the large vote (65 per cent voting yes on all of the bonds) demanded that a part, if not all, of the proposals be re-submitted to the voters at the August primaries.

Soil Research Discussed Before Engineering Foundation

Col. Charles R. Gow, consulting engineer, of Boston, and Dr. Charles Terzaghi, of Massachusetts Institute of Technology, addressed the semi-annual dinner meeting of the Engineering Foundation at New York on May 17. Colonel Gow remarked that a foundation science does not yet exist, and cited many cases of soil difficulties from his construction exerience to illustrate the statement. Knowledge of mud, quicksand and clay soils is particularly vague. He referred to the great current investment in foundations, and suggested that the savings to be expected from better knowledge of soil behavior would justify large expenditures for research. Dr. Terzaghi outlined the state of hydraulic research in the nineteenth century and the past two decades, and the development of soil research since 1913, when American and Swedish investigating committees on soil problems were formed. The Swedish work, concerned particularly with landslides along railway lines, led to sufficient knowledge of causes to make it possible to foresee and avoid landslide troubles in future construction.

Ambrose Swasey, who originally endowed the Engineering Foundation, and E. D. Adams, who added largely to the endowment, were guests at the dinner. Mr. Swasey in a brief speech expressed his pleasure in the development of engineering research, and voiced the faith that the movement represented by the Engineering Foundation will go on. Mr. Adams spoke of his presence last year at the celebration of the 500th anniversary of Louvain University, and his conception then of the plan to complete the great library, built by American contributions, by a clock and a set of chimes, as the gift of American engineers in memory of their colleagues who lost their lives in the World War.

The structure is to be dedicated on July 4, in the presence of a large number of American delegates.

A. D. Flinn, director of the Foundation, reviewed the principal work of the organization during the year. The fatigue-of-metals investigation has been closed, and correlation of the continuing fatigue research work has been taken over by the American Society for Testing Materials. A research in the field of iron alloys is shortly to be organized; the Foundation has offered a substantial contribution to its cost. Research in problems of chatter is under consideration. Research in dams is now centered at the University of Colorado, where models 5 ft. high are being tested. The research work in blast-furnace slags and in dielectric absorption is progressing at Wisconsin and Johns Hopkins respectively.

Commerce Commission Refuses to Order Los Angeles Station

The application of the city of Los Angeles, together with the California Railroad Commission, for an order to compel the erection of a union passenger station by the Southern Pacific, the Los Angeles & Salt Lake and the Santa Fe railroads has been denied by the Interstate Commerce Commission. It was held that the commission could authorize the railroads to proceed with the plan, but could not legally compel compliance. In accordance with this decision a certificate of public convenience and necessity was issued.

The project for a union station in the Plaza section of the city has been the subject of a bitter fight for several years. The railroads objected to the expenditure, estimated at $10,000,000, while the city has endeavored to enforce compliance with the plan by means of both state and federal courts. The decision of the Interstate Commerce Commission is the latest step in a long series of legal actions. In view of the opposition of the railroads, it is doubtful that the certificate of public necessity and convenience will have any effect on hastening construction.

Land on Kootenay to Be Reclaimed

Proposals for reclamation of lands for agricultural purposes along the Kootenay River, in British Columbia, have now received the sanction of the International Joint Commission, and the Creston Reclamation Company is authorized to proceed with construction. The proposals of the company include the construction of a dike in the Kootenay River flats and a diversion of Goat River into the Kootenay River. The commission orders that the company make suitable and adequate provision for the protection and indemnity against injury by reason of such works of all interests on either side of the international boundary. It is expected that 10,000 acres of fertile Kootenay flats will be made available for cultivation.

Washington Notes

Passage of Road Bill Over Veto Urged—Presidential Disapproval Of Muscle Shoals Bill Expected

By Paul Wooton
Washington Correspondent

IN VETOING the bill authorizing expenditures at the rate of $3,500,000 yearly for the construction of roads in unappropriated public lands, the President, in the opinion of Senator Oddie, presented faulty premises for the conclusions in his message. The Nevada Senator, who had charge of the bill, urged that it be passed over the veto, pointing out that the gasoline tax in Western states, with the exception of California, covers only from one-fourth to one-half of the amounts being spent by the states for roads. To require the states, in addition, to build the roads through the lands owned by the government, he declared, is unfair and beyond their means. He also pointed out that the $58,000,000 authorized for forest development, mentioned by the President in his veto message, includes expenditures for fire fighting and other work. Less than one-half is available for the construction of through roads.

Another Presidential Veto

Among the other bills vetoed by the President was the one enlarging the facilities of the Public Health Service. In his message to Congress he took the ground that the bill undertakes to limit the constitutional authority of the President in the making of appointments. He also took exception to the militarization of professional and scientific services. He contended that it makes for permanency of appointment and interferes with the reduction of government forces when there are economic reasons for such action. Among those who were to be given a commissioned status under the legislation were the sanitary engineers in the Public Health Service.

Muscle Shoals Doubtful

That the President will veto the Muscle Shoals bill is the general expectation on Capitol Hill at this writing. The amendment to the bill adopted by the House, which confined production to nitrates, was rendered ineffective by the agreement in conference which opens the door not only for the manufacture of mixed fertilizer by the government but for the production of a wide range of other products. The language of the conference bill in that particular reads as follows: "The board is authorized and directed to operate existing plants, to construct, maintain and operate experimental or producing plants at or near Muscle Shoals for the manufacture, distribution and sale of fertilizer, or any of the ingredients comprising fertilizer, or any of the by-products of the same." Opponents of the measure contend that this is an unnecessary and an unjustifiable entry of the government into business. The conferees reduced from 15 to 1 per cent the amount of fertilizer that may be distributed free and also required that all net proceeds be paid into the Treasury. The size of the board was cut from five to three members by the conferees.

Boulder Dam Prospects

As this issue goes to press the House is debating the Boulder dam bill. It is predicted that the bill will pass the House, but there is little reason to expect that the opposition in the Senate can be broken.

To Confirm Sturtevant

As this is written, indications all are that the Senate will confirm Carleton W. Sturtevant as the civilian member of the Flood-Control Planning Board. The point was made, when the commerce committee considered the nomination, that the intent of the law would be circumvented were the third member of the board under personal obligations either to General Jadwin or to Colonel Potter, the two other members. On the other hand, Mr. Sturtevant made a very good impression on members of the committee and evidently convinced them that he has an open mind on the problems involved and will be an independent arbiter between the conflicting viewpoints of the Army engineers and the Mississippi River Commission.

Will Rush Mississippi Work

An appropriation of $15,000,000 has been requested for expenditure under the flood-control act. The War Department appropriation bill, recently approved, carried an additional $10,000,000 of flood-control money. There has been some contention on the part of Mississippi Valley legislators that more than this $25,000,000 can be expended to advantage during the next year. The thought is that the work should be pushed as rapidly as possible so that the maximum amount of protection can be made available at the earliest time. As the Corps of Engineers, however, has the legal right to obligate funds authorized in advance of their appropriation, there will be no delay in the letting of large contracts.

The officers in charge of the various Mississippi River districts have been advised of the approximate amounts which they probably will have at their disposal so that planning for the work is going forward.

While no announcement has been made as to the exact division of the $25,000,000 that has been asked, it is believed that the principal items are approximately as follows: main river levees, $5,000,000; revetment, $7,500,000; Bonnet Carré spillway, $3,000,000; levees on the Red and Arkansas rivers, $2,000,000; dredging, $1,000,000; mapping, $500,000; surveys, $500,000; above Cape Girardeau on main river and tributaries, $1,000,000. A portion of the money will not be allocated until some progress has been made with the project.

Every effort is to be made to com-

plete the Bonnet Carré spillway at the earliest practicable time. Work now is in progress on its design. Just as soon as its exact location has been calculated steps will be taken to obtain the right-of-way. Work can begin at once on the side levees of the spillway when the rights-of-way have been obtained, as the completion of the design will have no bearing on that part of the work. The revetment work cannot begin until September because of the stage of the river, but the large amount of work to do in enlarging and strengthening the main river levees, as well as the levee work which must be done on the south banks of the Red and of the Arkansas, can get under way within five weeks after the money is available. The request for bids must be advertised for 30 days.

Bridges

The committee on interstate and foreign commerce of the House on May 21 had acted on 243 bridge bills during the session, which began in December. There are eight additional bills pending before the committee.

Niagara Water Utilization

The Niagara Falls Power Company has applied to the Federal Power Commission for the right to use all treaty water at Niagara Falls. At present that company is using 19,725 sec.-ft. of the 20,000 sec.-ft. available. The remaining 275 sec.-ft. is being used by various licensees on Eighteen Mile creek, between Lockport and Lake Ontario, where it is transported through the State Barge Canal. These licensees have announced their willingness to surrender their licenses. The water can be used to develop practically twice the amount of power at the Falls.

Congress Passes Road Bills

The bill authorizing a continuance of federal aid for highway construction, at the rate of $75,000,000 annually, was passed by the House unanimously and now goes to the President. Some uncertainty exists as to the President's attitude toward the measure. The House also has approved the Mount Vernon Boulevard bill. It already has passed the Senate and has the President's indorsement. The measure authorizes $4,500,000 for the procurement of a 200-ft. right-of-way from Washington to Mount Vernon.

Pennsylvania Engineers to Meet With Detroit Engineers

Members of the Engineers' Society of Western Pennsylvania are planning to leave Pittsburgh the evening of May 24 for Detroit, where they will join the Detroit Engineering Society in inspecting the Ford steel plant, the Trenton Channel plant of the Detroit Edison Company, the Lincoln Motor Company, the Ford airport and airplane factory, the filtration plant of the city of Detroit, the Kelvinator Company plant, and the plant of the Peninsula Stove Company. The return trip to Pittsburgh will be made on May 27.

Brief News

FOR ENLARGING ITS WATER SYSTEM Longmont, Colo., has secured an option on about 315 acres of land in the Lyons district for the purpose of procuring water rights. A reservoir to cost about $350,000 will be part of the new work.

THE REDWATER LINE of the Northern Pacific, extending 62 miles from Glendive, Mont., to Circle and Brockway, Mont., will be opened on June 2. The line, which cost $2,500,000, reaches a large area of farm land which has had no previous rail facilities.

DEEPENING BALTIMORE HARBOR to 35 ft. at mean low water has been recommended by the Chief of Engineers, provided the city of Baltimore furnishes a dumping area for the spoil or contributes to the cost of dumping. The cost of the project is estimated at $507,640. The area to be dredged is 1,500 ft. wide and 4,500 ft. long.

THE LAST SPIKE has been driven in the 150-mile link connecting the St. Louis-San Francisco Railroad with its recently purchased line from Kimbrough, Ala., to Pensacola, Fla. The connecting road was built from Aberdeen, Miss., to Kimbrough at a cost of about $7,000,000.

PURCHASE OF THE PROPERTY of the New Haven Water Company under an option provided in the contract between the company and the city has been decided against by a 24 to 9 vote of the board of aldermen, and the action has been approved by Mayor John B. Power. This action automatically continues for 25 years the contract entered into in 1902.

THE PASSAIC Consolidated Water Company has been upheld by the courts of New Jersey in its refusal to obey an order of the New Jersey Public Utilities Commission to write into its books the valuation of its property fixed at the time of the merger of the companies consolidated. The order was set aside by the State Supreme Court and that action was upheld by the Court of Errors and Appeals by a 6 to 5 vote.

INCREASED TARIFF RATES on sand and gravel which have been filed by five railroads serving Tennessee, Mississippi and Louisiana will be opposed by those affected in the Mississippi Valley. Protests will be filed with the Federal Tariff Commission, which will be asked to suspend the new rates until the opponents have had a chance to be heard.

PLANS FOR THE CONSTRUCTION and operation of a terminal railroad and other facilities to serve fruit, vegetable and produce traffic brought into Chicago by all railroads are outlined in applications filed with the Interstate Commerce Commission by the Chicago Produce Terminal Company and the Santa Fe and the Illinois Central railroads. The roads ask authority for the acquisition of control of the Chicago Produce Terminal Company. In a separate application the Terminal company asked authority to issue $12,000,000 of capital stock and construct the terminal. Under one section of the agreement the two railroads are to offer to sell and assign to other Chicago trunk line railroads an equal interest in the stock, but for the present they have subscribed for the whole issue. The proposed terminal would bring all wholesale fruit produce into one section around Western Ave. and West 31st St.

Random Lines

Buzz--Buzz

BY ELLDEE

While bent above our drafting board
With empty pouch and weary gourd
One chilly day not long ago
In vain attempts to rightly show
A contour wriggling 'round a hill,
A fly lit on the window sill,
Which was about a foot away
From where we carry on each day.

It was a common household fly
With legs and dauber, bulbous eye
And bloated fuselage and wings
And cushioned feet—disgusting things—
That somehow, strange to say, 'd hung on
When all its comrades long had gone
Unto that bourne whence Bobby Burns
Says in his book, "No fly returns."

As at its loathsome form we guyed,
Toward us it began to slide,
Anon and ever marking time
To scrub and polish at the grime
Which, caked upon its front feet, stuck—
No doubt germ-laden truck and muck—
Repulsive—dangerous, in fact;
And we resolved it should be smacked!

And, too, some "fly egg engineer"
Once said, while mooning o'er a beer,
That one lone fly—if left intact—
If by the swatter'd not been cracked—
Until the dandelions again
Bloomed joyously o'er vale and fen,
Would lay five million eggs—then some—
To hatch and broadcast filth and scum!

And so we slipped down from our stool
Noiselessly as an army mule
And from the drawer beneath our board—
Where for six weeks it had been stored—
Snaked out our swatter, raised it high
And swung it at the ding-danged fly,
A muttered cuss upon our lips
And in our trousers two new rips!
Bang!!—All went black—upon our board!—
As over it the "Higgins" poured;
While on the floor the bottle crashed—
And, strange to say, somehow was smashed!—
The map on which we'd spent long hours
Installing contours, roads and flowers,
Was ruined!—And we shed a tear—
As something buzz-buzzed past our ear!

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, June 25-29.

AMERICAN SOCIETY OF CIVIL ENGINEERS; Annual Convention, Buffalo, N. Y., July 18-20.

THE ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION has arranged for the following reports at the 1928 convention: "Care of Winter Laid Rail," M. J. Nugent, assistant engineer, Delaware & Hudson Railroad; "The Programming of Track Work," J. J. Desmond, roadmaster, Illinois Central Railroad; "Methods of Preventing Damage to Rail Ends," C. F. Allen, division engineer, Chicago, Milwaukee, St. Paul & Pacific Railway; "The Organization of Track Forces," A. A. Johnson, track engineer, Delaware, Lackawanna & Western Railroad; "Conservation of Revenue-Earning Equipment in Handling Maintenance-of-Way Material," R. H. Smith, superintendent, Norfolk & Western Railway. This annual meeting will be held at Detroit, Mich., Sept. 18-20. The secretary is T. F. Donahoe, Baltimore & Ohio Railroad, Pittsburgh, Pa.

Personal Notes

J. E. MORELAND, formerly division engineer of the Tennessee Department of Highways and Public Works at Nashville, has been appointed construction engineer for the department. J. R. LOVE, formerly assistant division engineer, has been appointed to succeed Mr. Moreland as division engineer. H. D. LONG, formerly senior resident engineer in Division No. 1 (Knoxville), has been appointed to the position vacated by Mr. Love.

JOHN P. WENTLING has been appointed director of the research division, Western Red Cedar Association, Minneapolis, Minn. Mr. Wentling comes to his new position from the division of forestry, University of Minnesota. Mr. Wentling received his professional training in forestry at Yale University, following which he spent four years with the United States Forest Service. Subsequent to that he has been identified successively with the Pennsylvania State Forest School and the University of Minnesota.

J. S. WATKINS, formerly first assistant engineer and before that district engineer, has been appointed state highway engineer by the Kentucky Highway Commission. He succeeds E. N. Todd, who resigned several month ago.

G. C. GRUBB has resigned as chief assistant city engineer of San Jose, Calif., to accept a position as resident engineer for Canadian Industries, Ltd., at the high explosives plant at James Island, B. C., operated by Canadian Giant, Ltd., a subsidiary of Canadian Industries, Ltd.

CHARLES H. FOGG, a graduate of the Worcester Polytechnic Institute, class of 1927, is now employed by the Iowa Highway Commission as proportioning plant inspector on concrete road construction. His headquarters are in Osceola.

H. R. LEONARD, chief engineer of bridges and buildings of the Pennsylvania Railroad, has retired from active service, having attained the age of 70 on April 13. He has been in charge of bridge and building construction of the Pennsylvania for 26 years.

HOWARD H. PARSONS, of Buffalo, N. Y., executive engineer of the Erie County (New York) Park Commission, in charge of the development of the county's public preserve system, has resigned to become chief engineer to the Hempstead Development Commission on Long Island.

GEORGE F. WHITTEMORE, civilian engineer, United States Engineer Corps, has been transferred from San Francisco to St. Louis, Mo., detailed to preliminary "scientific studies" on the Mississippi River. Mr. Whittemore has been connected with the Engineer Corps work on the Pacific Coast for many years, particularly in connection with jetties and harbor improvement projects.

MAURICE M. WYCKOFF, consulting engineer and attorney-at-law, announces that he is now associated with Maxwell Wyckoff in the law firm of Wyckoff & Wyckoff, 50 East 42d St., New York City. The firm will engage in the general practice of law, and Maurice M. Wyckoff, who has for many years been active as an engineer and builder, will specialize in the handling of legal matters connected with engineering, real estate, building operations and finance.

HENRY F. ANGELBERGER, who has been connected with the H. K. Ferguson Company, of Cleveland, Ohio, international engineering and building firm, since its organization ten years ago, has sailed for Japan to take charge of all the company's construction work there. Projects that will be under his supervision include a light bulb factor for the Tokyo Electric Company, the $1,000,000 Ford assembling plant in Yokohama and a factory building for the Nippon Electric Company, maker of telephones and equipment, which is nearing completion.

FRED W. STIEFEL has been appointed chief engineer of the Rosoff Subway Construction Company, of New York City, to succeed the late Harry C. Sanford, in charge of four subway contracts aggregating an expenditure of $26,000,000. Mr. Stiefel has been identified with subway and tunnel construction work in New York City for eighteen years.

HARRY A. BRINKERHOFF has resigned as city manager of Portland, Ore., to become affiliated with an engineering and construction company in Philadelphia.

Obituary

HOWARD G. KELLEY, formerly president of the Grand Trunk Railway system, died on May 15 at San Diego, Calif., of cerebral hemorrhage. He was 70 years old. Mr. Kelley entered railroad work in 1881 as an engineer on construction, location and bridge work for the Northern Pacific during the days when that road was being pushed westward. He later served with the St. Louis & Southwestern, the Minneapolis & St. Louis and the Iowa Central. In 1907 he was appointed chief engineer of the Grand Trunk, and under his control more than 10,000 miles of new track was laid. In 1911 he became vice-president in charge of operation, maintenance and construction, and in 1917 president of the system. Mr. Kelley retired with the formation of the Canadian National by the Canadian government.

ROBERT STEVENS PARSONS, chief engineer and former vice-president of the Erie Railroad, died on May 18 in Paterson, N. J. Graduating from Rutgers College in 1895, he entered the Erie service as a rodman and rose steadily to the position of chief engineer in 1915. Mr. Parsons was a member of the New Jersey Highway Commission and the American Society of Civil Engineers.

CHARLES N. WOODWARD, an engineer who helped to survey the route of the Union Pacific through Colorado and afterward was resident engineer of the Denver & Gulf Lines until it merged with the Colorado & Southern, died in Denver, on May 15. He was 72 years old. Mr. Woodward received his education at Hiram College, Ohio, and went to Colorado 47 years ago.

PETER STAUB, New Jersey highway contractor, died suddenly at his home at Pitman, N. J., on May 10.

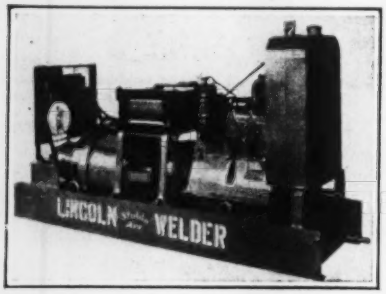
Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

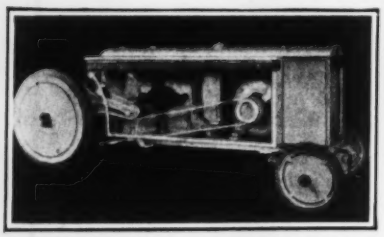
Manufacturers Develop Portable Welding Equipment

With the growing utilization of welding in the construction field, electrical manufacturers are rapidly developing equipment especially designed for such use. Three portable welding sets recently announced are described below.

The Lincoln Electric Company, Cleveland, Ohio, has announced a new gas-engine driven welder known as model S-1960. The unit is self-contained, light weight and readily portable. It has a rating of 200 amperes ac-



cording to National Electric Mfrs. Association Standards with a current range for welding duty of 50 to 300 amperes; it operates at a speed of 1,500 r.p.m. Motive power is a four-cylinder Continental engine, type H-9. Both engine and welding generator are mounted on a welded structural base. The whole unit weighs about 1,580 lb. and is 76 in. long by 25 in. wide. A feature of the equipment is that the generator is con-



structed of steel instead of cast iron. The complete magnetic circuit of the generator is also of a laminated steel design, and a steel switchboard is provided. All of these changes have been made with a view to reducing the possibility of damage in the field.

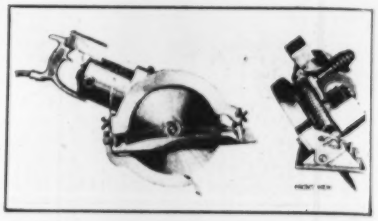
The General Electric Company, Schenectady, N. Y., has recently combined an electric arc welder with a Fordson tractor. The unit is marketed direct by the General Electric Company. It consists of a standard Fordson tractor, belt-connected to a type WD-300-A, 25-volt, 300-ampere, one hour rated 1,750 r.p.m. ball-bearing generator. This unit is mounted directly on the tractor and is protected by a metal canopy and canvas side curtains. The overall length of the complete unit is 12 ft., the height is 4 ft. 8 in., the width is 5 ft. 2 in., and the net weight is approximately 4,900 lb.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., recently made available a 200-ampere, single-operator welding set mounted on a three-wheeled steel chassis. The outstanding feature of this equipment is its simplicity of operation and compactness of construction. The set is started by connecting directly across the line by means of a "linestarter" and "line-start" motor. Starting and stopping are accomplished by a push-button. A single rheostat varies the arc current over the entire welding range. Accurate adjustment over the welding range from 60 amperes to 300 amperes is afforded by steps of 5 amperes. The motor generator and control equipment are assembled in an inclosed frame. The

exciter, which is overhung from the motor end, is securely fastened to the unit frame. This type of construction is said to guard the operator against injury and also protects the set from dirt and falling objects. It is said that the set will satisfactorily operate even when standing vertically on one end. The unit is rated at 200 amperes, one hour, 50 deg. rise on a resistance load at 25 volts, which conforms to standard rating of the N.E.M.A. The motor is wound for 220 or 440 volts and is assembled with the necessary connections for operation on a three-phase, 60-cycle circuit.

Hand Saw Permits Bevel-Sawing to 60-Deg. Angle

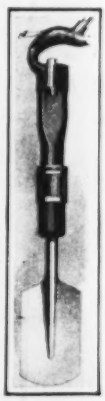
A portable electric hand saw recently developed by the Wodack Electric Tool Corporation, Chicago, Ill., and designated as Type B not only permits vertical sawing but provides for bevel sawing at any angle up to 60 deg. The latter is accomplished by a tilting saw-base which can be set and locked. Another feature of the saw is the use of a width gage, by means of which in vertical work various widths up to 6 in. can be sawed without the necessity of marking and with greater accuracy and uniformity. This new saw is especially advantageous for use in cutting roof rafters and concrete forms. It is powered by a General Electric universal motor operat-



ing on both alternating and direct current and is available in 110-volt, 220-volt and 250-volt sizes. The saw is furnished with one 11-in. and one 9-in. blade.

Pneumatic Digger Designed in New Type

A pneumatic digger, size 73, has recently been developed by the Ingersoll-Rand Company, New York City, incorporating new features in the design which are claimed to make it a more powerful tool than before. A self-seating plate valve is used which is claimed to give a smooth and very positive action, and the light weight, small travel and cushioned action make wear negligible. A new type tool-retaining device is also used which completely incloses the lower end of the barrel, which protects the tool from dirt, supports the lower portion of the shank of the blade, and makes possible easy assembly and removal of the rubber buffer and blade.



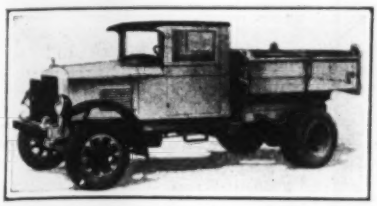
Two types of handles are furnished. An open-type outside trigger handle is standard, but a closed-type inside trigger handle can be provided if desired. The handle is bolted to the barrel. The length of the tool over all, without the clay scoop, is 20½ in. The length of stroke is 2½ in.

Three-Point Suspension Features New Road-Building Trucks

Two new 3-ton road-building trucks have been added to the line of the Indiana Truck Corporation, Marion, Ind. These models 127A and 627A are powered with four- and six-cylinder engines respectively. Model 127A is illustrated herewith. Both models are designed as two seven-bag batch trucks furnished with a 72-cu.ft. dump body.

A special three-point suspension mounting for the motor and radiator

units, known as the "Tors-Elim," is used on these trucks. When a cab is used, it is also attached to the three-point suspension mounting. The mounting is claimed to free the radiator, hood, cowl and cab from any of the torsional strain and vibration to which the chassis is always subjected. It is claimed that

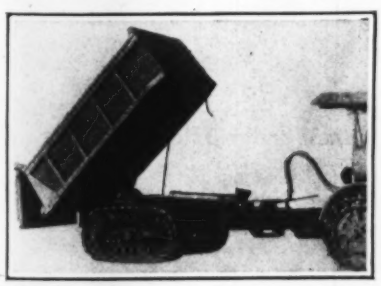


this new mounting assists greatly in steering the truck at high speed. Vibration is also claimed to be reduced. Hood squeaks are eliminated, and the gasoline tank, which is under the seat of the cab, is also free from extreme twists.

Hydraulic-Dump Crawler Trailer of Heavy Construction

Rear dump trailers in 4-5, 6-7 and 7-8 yd. capacities have been developed by the Athey Truss Wheel Company, Chicago, Ill., and mounted upon the company's patented crawler units. The 4-5-yd. (10-ton) units have 9 sq.ft., and the 6-7 and 7-8-yd. (15-ton) units have 12 sq.ft. of supporting area on the crawlers.

The bodies are operated by a Wood underbody hydraulic hoist which permits a dumping angle of approximately 55 deg. The steel body is of No. 8 gage steel, all parts hot riveted, and is reinforced with heavy longitudinal running boards and vertical flanged brackets. The tail gate will open either as shown in the accompanying illustration or by hinging at the bottom and opening from the top downward. Dumping is handled by the operator from his seat on the tractor. The tail gate is



either automatically or manually operated. The 4-5 yd. capacity trailers are developed for use with the Caterpillar "Thirty," while the other two models, the 6-7 yd. and the 7-8 yd., were developed for use with the Caterpillar "Sixty."

New Publications

Centrifugal Pumps — LAWRENCE PUMP & ENGINE COMPANY, Lawrence, Mass., has published a new bulletin D-25 illustrating and describing its "Vortex" centrifugal pumps. Both gasoline engine and electric motor driven units are illustrated, mounted both on trailer trucks and on skids. Capacity, speed and horsepower tables are given for all types.

Floodlighting — GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has published a 27-page bulletin GEA-161-B illustrating and describing its various types of "Novalux" floodlighting projectors. Many illustrations are given of important public buildings throughout the United States in connection with which these floodlights are used. Tables of dimensions and capacities are also included. Projectors are shown for such services as railroad yards, searchlights, aviation beacons, airport boundary lights and intermediate aviation field lights.

Road Machinery.—AUSTIN WESTERN ROAD MACHINERY COMPANY, Chicago, has published three new folders describing respectively its motor-grader built around McCormick-Deering and Fordson tractors; its motor-roller of three-wheel and tandem types in various sizes; and its leaning-wheel graders in various types and sizes.

Curb and Gutter Forms—BLAW-KNOX COMPANY, Pittsburgh, Pa., devotes its bulletin No. 1924 to its steel forms for curb, curb and gutter and integral curb and sidewalk work. The lock joint and staking system is treated in considerable detail. Each type of form is illustrated and described, line drawings being given to show all important dimensions.

Gypsum Partition Tile—THE GYPSUM INDUSTRIES, Chicago, has made available a new booklet in which is given a discussion of gypsum partition tile by Henry J. Schweim, chief engineer of the Gypsum Industries. The booklet contains a number of illustrations of partition tile in various office buildings and hotels throughout the country. It points out such advantages of the tile as ease of erection, saving in dead load, ease of alteration, and provision of ground insulation and fire protection. Several pages of specifications and drawings are included.

Iron and Steel Products—AMERICAN ROLLING MILL COMPANY, Middletown, Ohio, has published a 41-page booklet entitled "The Story of Armco." The booklet tells the story of the origin and development of the company, of its pioneering in iron and steel research and its development of a world market for its standard and specialty products and of its policies which are to form the basis for its future growth.

Acetylene and City Gas—INTERNATIONAL ACETYLENE ASSOCIATION, 30 E. 42d St., New York City, has published in pamphlet form two papers read before its annual convention in Chicago last November. These papers are entitled "Acetylene and City Gas" by J. K. Mabbs, Union Carbide Sales Company, New York City, being some laboratory studies made to show the relative values of fuel gases for cutting metals by oxidation; and "City Gas versus Acetylene" by J. L. Anderson, National Carbide Company, New York City, being a study of the comparative merits of the gases for cutting considered from the operating standpoint.

Motor Rollers—HUBER MFG. COMPANY, Marion, Ohio, in a 36-page catalog describes its four-cylinder automotive type motor roller which was developed in 1923, as a pioneer in this type of equipment. Many improvements have since been made and this catalog describes the various advantages of the motor-roller as now constructed, giving illustrations of the various machine details and of the machine in use under various conditions in the field.

Solar Ephemeris—KEUFFEL & ESSER COMPANY, New York, has published its Solar Ephemeris for 1928, with which is included other tables and data useful to the surveyor. This new edition remains practically the same as previous ones except that the method of determining the meridian by observing Polaris at any hour angle is more fully explained.

Rock Drilling — INGERSOLL-RAND COMPANY, New York City, has published a book of reprint articles largely from the *Compressed Air Magazine*. Included in the collection are articles on the Cascade Tunnel, the Chicago Intake Tunnel, the Conowingo Dam, the New York subways, and the Vermont marble quarries. The articles are bound together in a folder.

Centrifugal Pumps—ALDRICH PUMP COMPANY, Allentown, Pa., has published a second edition of its Data Book No. 70, covering its double-suction volute centrifugal pumps. Besides standard specifications and illustrations, tables of standard ratings and dimensions are included. Performance charts for centrifugal pumps and a number of tables and formulas complete the 15-page booklet.

Heavy Duty Trailers—FRUEHAUF TRAILER COMPANY, Detroit, Mich., has published an 11-page booklet illustrating and describing its various types of heavy duty trailers for transporting contractors' equipment. The trailers shown range in size from 15 to 60 tons.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; annual meeting, San Francisco, Calif., June 11-14.

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Certified Building Construction Advocated in Chicago

Rating new buildings by the quality of their construction and equipment is being advocated by the Certified Building Registry, Chicago, as a means of securing good first-mortgage bonds and of obtaining well-built, safe and comfortable structures that will require minimum operating cost for heating, maintenance and repairs. Firms which lend money on buildings often find the construction below desirable standards, while investors in first mortgage real estate bonds have no check on the quality of the buildings they have helped to finance. The registry code includes ratings for walls, roofs, chimneys, heating plants and other features, these ratings being comparisons with a given standard and based upon inspections made during the construction as well as on examination of the plans.

This system, which is said to have the approval of important real estate, investment and insurance interests, is claimed to have advantages in several ways: (1) it would enable contractors to borrow a higher proportion of the cost on structures built and certified according to the registry code; (2) it would protect purchasers and provide them with durable buildings, economical in fuel and repairs; (3) it would protect investment interests; (4) rated or certified buildings would command higher values for loans and sales; (5) firms supplying building materials and equipment would benefit by the elimination of skimped construction. The first rating of buildings on this system was done at Flint, Mich., about two years ago, when a large number of small homes were being built to accommodate the rapidly increasing industrial population. At present the registry system is being applied to the smaller class of residences and apartment buildings, but it is proposed to extend it eventually to more important structures such as hotels, offices and large apartment buildings. Clyde A. Mann is director of the Certified Building Registry, 11 South La Salle, St., Chicago.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended May 24, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
May 24, 1928	**$29,076**	**$32,247**	**$61,323**
May 17, 1928	43,466	50,322	93,788
May 26, 1927	18,931	45,733	64,664
Jan. 1 to date:			
1928	510,701	876,263	1,386,964
1927	434,326	728,225	1,162,551

E. N.-R. Index Numbers

Cost		Volume	
May 1, 1928	**207.00**	**April, 1928**	**316**
Apr. 1, 1928	206.40	March, 1928	318
May 1, 1927	206.80	April, 1927	257
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

Large Public Utility Offerings Include Tunnel Financing

Public utility offerings for the week ended May 18, 1928, were exceeded by only one other week this year. The offerings of the group totaled $86,018,000, of which $35,000,000 Associated Gas & Electric Company debentures constituted a refunding operation. The Detroit and Canada Tunnel Company offered two $8,500,000 issues. This is the first offering of securities of a privately owned enterprise for construction of a vehicular tunnel. Traffic between Detroit and Windsor, Ont., is now handled by ferries and railroads, but a bridge is being constructed.

New bond offerings in May, 1928, totaled $416,550,000, including the week ended May 18. The corresponding weeks last year showed total offerings of $556,190,000, and all groups except foreign, real estate and miscellaneous showed smaller offerings in May, 1928. For this year to date there were only two classes of bonds offered in larger volume than a year ago. These were foreign and real estate bonds.

BOND OFFERINGS BY GROUPS TO DATE

	1928	1927	Per Cent Change
Railroad	288.7	364.5	−21
Public utility	674.7	766.9	−12
Industrial	416.5	504.7	−18
Municipal	332.1	477.4	−30
Foreign	716.1	611.0	+17
Real estate	156.7	108.4	+45
Miscellaneous	69.1	101.5	−32
	2,653.9	2,943.4	

RECENT IMPORTANT BOND OFFERINGS

	Amount	Interest	Yield
Public Utility:			
Detroit & Canada Tunnel Co.	$8,500,000	6	6
Detroit & Canada Tunnel Co.	8,500,000	6½	6½
American Gas & Power	6,500,000	5	5.30
Texas Cities Gas Co.	5,400,000	5	5.10
Indiana Electric Corp.	3,268,000	5	5
Electric Public Utilities	3,000,000	5	6
Islands Edison Co.	2,250,000	5½	5.80
Public Utilities Cons.	1,500,000	6	6¼
Public Utilities Cons.	4,000,000	5½	5¾
Cooper River Bridge, Inc.	3,700,000	6	6¼
Central Indiana Pwr. Co.	3,000,000	4½	5
Indiana Central Tel. Co.	1,400,000	5½	5.63
Municipal and Land Bank:			
Illinois	7,000,000	4	—
California Joint Stock Land Bank Farm Loan	2,000,000	5	4.55
West Orange, N. J.	577,000	4¼	4.10
Atlantic City, N. J.	2,307,000	4½	4.20
Hempstead, N.Y., school	500,000	4½	4.05
Miscellaneous:			
Hawaii public improvement	1,575,000	4½	3.95

1927 Unit Costs of Office Building in Canda

Unit costs of an average fifteen-story office building in Ontario, Canada, are tabulated below. The percentage figures were based on 1927 construction costs of several large office buildings. Individual variations from these averages naturally occur as a result of different conditions affecting construction methods and varying designs affecting materials used. The detailed percentage costs were:

	Per Cent of Total Cost
General conditions	5.25
Structural frame	22.00
Brick and masonry	15.00
Plumbing, heating and ventilating	10.00
Electric wiring and fixtures	2.25
Marble tile and terrazzo	1.75
Elevators	7.50
Stone	3.00
Ornamental iron	2.25
Metal windows	2.25
Lathing and plastering	4.00
Roofing and sheet-metal work	0.75
Metal store-fronts, glass and glazing	1.00
Kalamein work and fire doors	2.50
Painting	1.75
Mail chutes	0.75
Special decoration allowance	0.50
Excavations	1.00
Foundations	1.75
Hardware	1.75
Fireproof partitions	2.50
Rough and finished carpentry	3.00
Vault doors	0.50
Linoleum floors	1.50
Overhead and profit	6.00
Total	100.00

Building Costs Remain Stable During Whole Year

Remarkable stability of building costs is strikingly illustrated by the index numbers compiled by the American Appraisal Company. The general figure covering four types of building construction in nine sections of the country is 202.9 for April, 1928, 202.9 for March, and 203.2 for April, 1927. This checks very closely with the *Engineering News-Record* Cost Index Number covering construction in general, which now stands at 207, compared with 206.8 a year ago. A general increase of from two to five points is noted for New England, all types participating in the advance. One to two points decline is reported for the Pacific Coast states and for Texas and the Northwestern states.

Some Foreign Highway Programs Just Announced

Nova Scotia plans to spend in 1928 between $3,500,000 and $4,000,000 for the reconstruction of 300 miles of roads. The Province of Saskatchewan is taking bids for 37 miles of drainage, culverts, ditches and bridges.

The Congress of Panama has passed a bill providing for the construction of a road from the capital to Porto Bello, thence to Colon. This highway will be operated by the concessionnaire on a toll basis, and the necessary machinery and materials to build it will be imported duty free.

The Italian government has approved a measure to construct an automobile highway from Bergamo to Brescia, a distance of about 30 miles. The estimated cost is $2,850,000.